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CONTENTS.

THE CATTLE CONFERENCE AT LUCKNOW.

By W. H. MORELAND, C.I.E., I.C.S.,

Director of Land Records and Agriculture, United Provinces of Agra and Oudh.

I HAVE been asked by the Editor to give a short account of the proceedings of the Cattle Conference which was held last August at Lucknow, and which excited a quite exceptional amount of attention in the United Provinces. The idea of the conference was not a novelty, since it had been preceded by the Industrial Conference of 1907 and the Sanitary Conference of 1908, the object in each case being to ascertain through free discussion the views of representatives of the public, and to formulate the main lines of a policy to be pursued by Government on the subject under consideration.

The Cattle Conference had its origin partly in the general feeling of dissatisfaction caused by the high prices of cattle and of dairy produce, and partly in the desire of the departments most directly concerned to obtain an authoritative expression of opinion on subjects where the religious and social sentiments of the people can never be left out of account. Membership was limited to representatives of the province, but among the visitors were the Inspector-General of the Civil Veterinary Department and two representatives of the Military Department. The members fall naturally into three groups, the divisional representatives, the Government nominees, and the official element. The divisional representatives were chosen on the nomination of Commissioners from among Indian landholders who were most likely to represent the feelings of the agricultural population; the Government nominees were for the most part representative of special interests, and included besides European planters and landholders and representatives of the Upper India Chamber of

Commerce, such authorities as Mr. Abbott of Jhansi, the pioneer of the Central Indian hay-trade, and Mr. Keventer of Aligarh, the leading dairyman in Northern India; the official element consisted of representatives of the general administration and of the Public Works, Forest, Agricultural, and Veterinary departments. In all about forty members met under the presidency of the Hon'ble Mr. D. C. Baillie, a Member of the United Provinces Board of Revenue; and it must be said that a more competent and authoritative Conference could scarcely have been brought together.

The proceedings opened on the 4th of August when the Lieutenant-Governor welcomed the members and the president delivered his address. The Conference then divided into committees which sat for the next three days, discussing the agenda with an entire absence of formality, set speeches being practically ruled out, and the tone of the discussions being throughout friendly and conversational. The recommendations of the committees were then discussed by the full Conference, and transmuted into a series of Resolutions which form the final record of the results of the deliberations. The discussions were for the most part conducted in the vernacular, and the papers circulated daily were accompanied by translations, so that no difficulty was caused by the presence of members unacquainted with English.

Turning to the Resolutions that were passed, the first group recorded the actual position. It was held that though prices have increased, especially for the better class animals, there was no actual insufficiency of working cattle; but there were differences of opinion on the question whether the class of animals had deteriorated. It was recognised that the decrease in cows disclosed by the cattle-census was probably temporary, being due to recent famines, and that there is a tendency to substitute buffaloes for cows among dealers in milk. The general feeling was that the fully-cultivated districts of the province must continue to depend for the supply of cattle on the grazing districts which lie on the North, South and West, and that the protection of the grazing grounds was a matter of great importance.

When, however, the question of legislation to protect grazing-grounds came under discussion, there was a marked divergence of opinion: the representatives of the cultivated districts desired to have the large grazing-grounds protected by law, but this was strenuously opposed by the representatives of those interests, who in turn recommended the reservation of grazing areas in the cultivated districts, a proposal that was opposed by some of the representatives of the cultivated districts. Eventually no agreement could be come to on this question, and the present position is likely to be maintained: the larger land-holders voluntarily preserving the existing grazing-grounds, though objecting strongly to being compelled to do so, and the smaller men breaking up the land for cultivation until the necessary adjustment in prices ensures its retention for grazing.

Leaving the recognised grazing-grounds, the Conference then turned to consider the question of preserving and improving waste land of other kinds. Recommendations were made for administrative action tending to increase the number of the groves which are such prominent features in the landscape of the province: co-operation was offered in the efforts of Government to increase the productivity of the ravine area: and a request was made for experiments to be instituted to show whether fuel and fodder reserves can be made a commercial success on land which is on the margin of cultivation.

The Conference then considered the fodder-supply, and an interesting discussion took place on the contention which has been frequently advanced in the past that the provision of more fodder merely leads to the survival of useless cattle, and that cattle will always multiply up to the limit of subsistence in years of plenty and die off in years of dearth. It was conclusively shown that this contention no longer applies to the circumstances of the province, as animals past work are now speedily eliminated in almost all districts. Thus, the main argument that has been used in the past in support of a policy of inaction is no longer available, but few definite recommendations for increasing the fodder-supply

could be made, as it was recognised that this must be governed mainly by economic conditions.

The next discussion of special importance related to the supply of bulls. So far as the valuable breeds in the north of Oudh are concerned, it was recognised that the bull-depôt now being established by Government should meet the needs of the case; but there was a general feeling that Government should provide a supply of ordinary bulls, which landholders could purchase in order "to supplement, and it is expected in time to supplant" the present system under which the village cows are ordinarily covered by sacred bulls. The recognition by such a body of landholders that the time-honoured system of providing bulls as a religious act is wearing out and requires to be supplemented, and eventually supplanted is a matter of the greatest interest, both socially and economically, and raises a problem of much practical importance in the supply of sound bulls at reasonable prices.

The question of introducing improved breeds either for work or for dairy purposes produced another interesting discussion, in the course of which it was clearly recognised that organised action is necessary, one or more bulls and a suitable number of cows being introduced simultaneously into a definite area. It was thought that large landholders might undertake this on their estates, and that it is a most suitable function for local agricultural associations, Government assisting in the work of purchasing the stock, and where necessary granting advances towards its cost.

Turning to the prevention of disease, the increased popularity of the Civil Veterinary Department in recent years was shown in a most gratifying manner by the general demand for more veterinary assistants and for increased attention to the treatment of cattle; and the Conference was able to recognise that the prejudices against inoculation are disappearing and that the influence of landholders is the most important factor in this matter.

The supply of dairy products was the next topic, and the Conference declared that there was no disproportionate rise in

price, but that adulteration was greatly on the increase, and they recommended legislation, applicable only to towns, providing that nothing should be sold as milk, butter, or *ghi*, which is adulterated. A similar recommendation had previously been made by the Sanitary Conference, and it is understood that legislation is in prospect. Recommendations were also made to municipalities for the encouragement of sanitary dairies in their vicinity, and to the railway systems for developing the supply of milk by rail.

Finally a recommendation was made for an enquiry into the sources of cattle-supply to the various districts, and for the collection of information on various points which had come up during the discussions: and the Conference broke up with mutual expressions of cordial good-will between the official and the non-official members. Perhaps the final result can best be summarized in the following words, with which the Chairman submitted its proceedings to Government:—

"It cannot be claimed for the Conference that it has suggested any fresh or original measures to help towards the solution of the problems considered by it, but the meeting was certainly not without value. It has led to the discussion from all points of view of the questions raised by a considerable body of landholders, and it has given evidence of a general desire to give personal assistance in future measures and assurance that there is no general tendency to look at these questions from a narrow or sectarian point of view. The general agreement of the members of the Conference gives good reason to believe that so far economic changes have not produced acute difficulties in connection with the production of plough and milk cattle, and affords indications that further developments will be on natural lines."

THE INTRODUCTION OF IMPROVEMENTS INTO INDIAN AGRICULTURE.

By HAROLD H. MANN, D.Sc.,

Principal, Agricultural College, Poona, Bombay.

THE introduction of improvements into Indian Agriculture is surrounded by peculiar difficulties. The fact that, generally speaking, the agriculture of the country is in the hands of very small holders, who form a naturally non progressive class, is the first of these. Perhaps of equal importance with this is the rigid separation, which has long existed and still exists, between the different classes of society throughout the larger part of the country, for as a result of this, the educational movements of the past few years have hardly touched the cultivator of the land. He, in fact, still remains largely out of contact not only with progress, but also with the knowledge of progress. And, if you add to these reasons the fact that the Indian farmers are usually men whose capital is little more than the ownership of their very small area of land, who work almost entirely on borrowed money, there results a condition of things which is eminently unfavourable to progress.

This condition of things places India in the opposite extreme to those countries where the application of modern scientific discovery to agricultural practice has been most marked. Take, for instance, the United States of America. *There* your farmers are men of energy, of, at least, a little capital, and who are intensely alive to all that is passing in the great world; *here*, on the other hand, they are isolated, they are poor, they are usually content to go on in the way of their fathers. *There*, the existence of a large and well-organised agricultural department, of agricultural societies, of rural banks is the result of initiative among the

farmers themselves: *here*, that initiative is all but entirely absent. *There*, as a result, experiment and discovery are followed closely by a large and intimately-interested community: *here*, the results of any experiment or any discovery have to be forced on the attention of the people, and its adoption in practice has to face an amount of inertia, and a lack of available capital that would seem inconceivable in most other countries.

And yet, it must not be understood that the Indian cultivators are themselves hopelessly conservative and prejudiced. The difficulty seems rather to be, first, to get information actually into their hands from a source in which they have confidence, then to convince them of the utility of the suggestion which is made, and finally to show them that it will pay them to adopt it. When this has been done, the increasing experience is that the Indian cultivators are by no means over-conservative. They are quick, in fact, to see any advantage. But, owing to their economic position, they must be sure of the disinterestedness of the information, they must be fully convinced of the value of the improvement, and they must be sure it will pay.

And what will pay under Indian conditions is quite a different thing from what will pay in many western countries. It is impossible to estimate the value of any method or of any change, unless the financial conditions under which a cultivator works are fully realised. As already stated, it is probable that over the greater part of India a cultivator does not have any ready capital. He has to borrow every year, either in money or in kind, for the purpose of meeting the expenses of cultivation, and the rate of interest which he has to pay often, if not usually, amounts to from 25 to 75 per cent. per annum. It is, therefore, not sufficient that an expert in agriculture can prove to himself that a new method will give a return of 10 or 20 per cent. over existing practice. Account must also be taken of the extra capital involved, and the rate of interest which will have to be paid for it. As the cultivators have no capital they can take no risks. Unless they can be shown that the new method is a certainty, the cultivators will not, and rightly will not, take it up. A

certainty will mean, as a rule, to a ryot, something which will give him a return of over 25 per cent. on any extra capital invested, and this fact must be continually in the minds of all those who propose innovations in Indian agriculture. This means, in other words, that until cheaper money can be made generally available, any improvement which can be brought into practice, if it involves any outlay, must be of a very marked character. It means, further, that the connection of effort for cheapening of credit by means of co-operation or otherwise, and that for agricultural improvement is very close, closer perhaps than is generally realised.

But apart entirely from these questions, the introduction of improvements into Indian agriculture is no easy matter. But a considerable amount of experience has been gained in the last few years. Many failures have occurred: some successes have been obtained, and with a view to bring together the results of these experiences for future use a committee was appointed at the meeting of the Board of Agriculture in 1908 to consider and discuss them, and express an opinion as to their applicability in the future. A second committee was appointed in 1909, and the results of its deliberations, modified as they have been by careful local examination of the statements, will be issued very shortly. It seemed, however, that there was room for a general statement of the methods which had been found to be most effective in the present article.

To introduce anything which may be considered an improvement in the special conditions of Indian agriculture, the first necessity is that you should be absolutely certain that your process or implement is actually an improvement under the conditions existing in any particular spot. This would, at first sight, seem a truism, and and so it is. And yet, its neglect has led in the past to the greatest failures, to the loss of confidence by the *ryots*, and to sets-back to progress whose seriousness it is difficult to estimate. In the older days, for instance, American cotton was introduced into India in very large quantities. No experiments were made as to its suitability in many of the

areas, where it was planted, either agriculturally or economically. What was the result? The cotton failed in many areas, of course. This would not have mattered so much, perhaps, in itself, but confidence was lost, the department introducing the cotton was thought by the cultivators to be unpractical, and they hesitated, to say the least, to adopt any other suggestion. The same story has been repeated elsewhere: new implements, new crops, new methods, excellent in themselves, have occasionally been introduced without adequate knowledge of local conditions, and without sufficient testing. The result has too often been failure, loss of confidence, and general distrust. It cannot be too strongly insisted on, that nothing can justify the recommendation of any supposed improvement, unless it has been preceded by careful experiment, and by the most careful local study.

But what does this careful local study mean? Does it simply mean that the method has been carried out successfully on an experimental farm in the same neighbourhood? So far as it goes, such experimental testing is excellent, but it is by no means all. Anyone who has dealt with this subject in practice must know that the difficulties which occur to an experimental farm manager are a very different thing from those which occur to a ryot. For instance, on an experimental farm a particular imported iron plough does excellent work, it is more economical in every way, and the crops are better. You take it out, and are met at once by a villager who acknowledges its value, but at once asks how he is to get it repaired if he adopts it. No country *mistri* can deal with it, spare parts cannot be stocked either by the cultvator himself or in the village shop, and the plough, however good, has to wait until this difficulty is overcome. Or again, you find a particular manure for sugar-cane. It gives excellent results in growth, and yield of *gul*. You recommend it, and are at once met by the statement that this manure always lowers the value of the *gul*. The lowering is relatively small, but there it is. It is probable that among the mass of samples on your experimental farm the difference has never been noticed.

especially as it is a commercial difference not capable (so far as I know) of being detected by chemical analysis. But you must answer the difficulty or your manure will have to wait. And so on. Instances might be multiplied, but the above must suffice to show the absolute necessity of local study as well as experiment before it is attempted to introduce an improvement. The whole resolves itself into being absolutely certain that your novelty is good and is applicable under the special local conditions.

But this being ensured, the next step is to secure the confidence of the people. And here is perhaps the greatest difficulty of all. Indian ryots have from time to time been exploited by people of the most various kinds, sometimes with, sometimes without, intention, so that they are rightly suspicious. If anything is suggested, they at once look for the motive. What has the man to gain by it? What has the Government he may represent to gain by it? Is he the agent of someone else? Such are the questions which at once rise in his mind, and have to be met.

The winning of confidence has been accomplished in various ways; but whatever the method, it is of the first and most vital importance to the whole success of the work attempted to be done. In many parts of India the attempt has been made by the formation of local associations of agriculturists and those interested in agriculture among whom the improvements suggested can be discussed, by whom they can be tried, and, through whom, when successful, they can be extended among the surrounding people. Perhaps the greatest success in this direction has been achieved in the Central Provinces. There the members are nominated by the local authorities, they have as their chairman the District Officer, whenever they meet one of the senior officers of the agricultural department is present and membership involves readiness to try some novel method on the member's own land. All proceedings are in the Vernacular, discussions are free, and enthusiasm is often aroused, and these associations have succeeded in bringing the agricultural department into touch with the cultivators, and in giving them confidence in one another. As a result

numerous improvements have been made. Improved varieties of Jowar, sugar-cane and other crops have been introduced, the fighting of *smut* in *Jowar* by pickling the seed has been largely adopted, in some of the backward tracts great improvement in rice cultivation has taken place, and new, improved implements are now in some districts regularly used. I have quoted the Central Provinces because the idea of agricultural associations has been more developed there than elsewhere, but they have been formed in other provinces, sometimes as more independent, sometimes as more official bodies, with varying success. The movement is in its infancy, but enough has been seen to indicate the general lines in which they are likely to be most valuable. In the opinion of the Committee (whose work I am summarising), it may be said that "their utility seems largely to depend on the presence of a body of men directly interested in cultivation, on the personal touch of the higher staff of the agricultural department with the members, on the definite engagement by the members to do definite pieces of work, and on the regularity of meetings, inspections, and reports .... No association, large or small, should be formed till there is something of the nature of a spontaneous demand on the part of the people themselves or until the agricultural department is in a position to advise and guide them in their work. Where the agricultural department has failed to create such interest the association is bound to fail in its object."

The next method which has been used, is that of demonstration of the value of improvements on the spot, usually by instituting a demonstration farm for the purpose, or by temporarily hiring some land from an actual cultivator. In either case, if it is to do any good, the confidence of the people must be won either before or during the demonstration itself. Nothing is more common than to find that the cultivators have a haughty disdain of what is done on a Government farm,—it is considered that, however good the results may be, they can only be done under conditions of money and *personnel* that only Government can secure. Hence, except in

exceptional cases, it is probably not wise to institute a special permanent farm for demonstration purposes; by far the better way, so experience shows, is to engage a temporary plot or utilise a private farm. It is essential that everything be done as a cultivator can do it, and that the man in charge should be a cultivator himself, or at any rate one with whom they can get into perfect intimacy. Supervision there must be, but it is essential that the man actually in charge should be of the same type as the people he is working among. He has then two things to do, to gain their respect and confidence, and to show that his method is better than that which is adopted round about him. He must understand, too, that the success of the demonstration will be judged by the extent to which it is adopted, and that this is the only test.

Working on these lines it has been possible to make considerable progress in Madras, in the Central Provinces, and in several other parts of India, new varieties of crops have been introduced, new methods have been largely adopted, and it seems likely that this will form one of the most effective means of introducing new matters into the practice of cultivators.

These methods are not limited to matters of cultivation. New machinery can be equally well shown by men of a similar type. A gang of men has for instance been employed for years in Bombay, demonstrating from place to place, the best methods of boiling *gur* (crude sugar); the use of reaping machines has been brought to the notice and into the practice of agriculturists in the Punjab similarly, and many other cases might be cited. The essential point in it all, is that everything should be shown under cultivators' conditions, by men who are themselves intimately in touch with the people and their problems.

Other methods have been utilised for gaining the confidence of the people, the essential preliminary to doing very much for the introduction of improvements. In the United Provinces and in the Central Provinces, advantage has been taken of the period of stress following severe famine to help the cultivators with large quantities of good seed, and the like, and the confidence thus

gained has been very great. Again travelling agents have been employed in going from place to place, generally on some special quest, and getting into touch with villagers and cultivators in Bombay. In this case the men employed should be of considerable experience, be thoroughly imbued with the fact that they are the servants of the people, and be, if possible, cultivators themselves. And so on. But confidence must be gained, I would again insist on the matter, before anything material can be done.

When the confidence of the actual cultivators has been secured, the greater part of the difficulty is over. It is then only a matter of showing, of clearly proving, that what you recommend is good and will pay, and the chief trouble is to ensure that your information actually reaches the cultivators themselves.

The number of methods which can be adopted for this purpose is very great. The most certain in effect have been already referred to, the formation of local associations of agriculturists where matters can be freely discussed, and in connection with which members will make trials for themselves and for their neighbours to see, and the institution of demonstrations by the agricultural department either on cultivators' land specially hired for the purpose, or by special demonstration farms. Where applicable, both these methods are effective, in almost all cases. The spreading of demonstrations over larger areas under the control of the agricultural department, however, involves a very large staff, and a very well-trained staff. This is not likely to be available for many years to come, if ever, but so far as it is available, whenever there is anything definite to be shown, the method of local demonstration has proved itself extremely effective. As already stated, the Committee feel that experience has shown that plots taken from cultivators for a short period, and placed under a man who is himself a cultivator well trained for the particular demonstration in hand, are more effective than *actual demonstration farms. Such plots should be small, should limit themselves to special and definite demonstrations, should* show nothing which is not certain to be a success, and should be accessible to surrounding cultivators at all times.

But beyond the relatively small area which even a very large extension of such demonstration areas would cover, we must rely on agricultural associations to meet the need to a large extent. As already described, they enable us to carry the ocular demonstration of our improvements to a very much larger area, but their number is circumscribed by that which can be covered by the senior staff of the agricultural department, who must act as inspiring and suggesting influences to everyone. However enthusiastic local men may be, they expect and require constant touch with the experts of the agricultural department, and the extension of associations is limited by the possibility of giving that touch. It is no use sending inferior men to them, those employed to guide and assist associations must be of considerable experience, usually well-skilled in the vernacular, capable of inspiring work, and with a stock of suggestions for improvement which are proved successes, and which will meet the cultivators' needs.

The last point perhaps merits a short digression. It is impossible to insist too strongly on the necessity for finding out what are the cultivators' difficulties and needs, before any attempt to introduce improvements is made. It is a slow business to attempt to bring into use anything for which a need has not arisen. It is useless to talk of artificial manures to a man whose crops are failing for want of water, and yet this has often been done in the past. It should always be remembered that the finding out of the cultivators' wishes and needs is the first necessity, and the devising of means to meet them the second, and their presentment to him in one way or another then follows and is welcomed.

To enable improvements to be carried out over a wider area, we must return to those methods which have been successes in other lands, such as exhibitions, shows, publications and so on. They will be successes if you already have the confidence of the people, otherwise they may cause much talk, but will lead to little real effect. Hence the value, so far as ultimate results are concerned, of these methods has been very various. But if the essential

condition is obtained, then a great deal depends on the manner in which these methods are adopted. A large amount of energy has been spent in recent years in organising large exhibitions in several Indian Provinces in which a vast amount of work has been put into the agricultural section. These have been held in Bombay, at Calcutta, and the culmination was reached in that recently held at Nagpur. In each of these cases, and particularly at Bombay and Nagpur, very great efforts were made to secure the attendance of large numbers of actual cultivators, and to show them everything which was to be seen. These exhibitions have certainly been effective in inspiring very great interest, have made the agricultural departments more widely known, have spread the knowledge of advanced methods into corners where this had never before penetrated, and have directly led, in the hands of the more substantial cultivators, to the introduction of seed and implements.

Such large exhibitions can only, however, be organised on special occasions and under special circumstances. Local smaller shows can be held at more frequent intervals, and range in size from institutions like the Lyallpur fair in the Punjab, annually attended by one hundred thousand people, to small *taluka* shows in parts of the Bombay Presidency, or to the demonstrations which are made in connection with smaller cattle fairs and festivals in Madras. On the whole, the Committee have felt that if such shows are to lead to real effective improvement, their organisation should be very carefully done. While local effort may and should arrange the show, the part which the agricultural department takes in it should be very carefully organised and attended to by one of the superior staff of the agricultural department. Agricultural products which are not and cannot be produced on the cultivators' own lands should be excluded. As many things as possible should be shown in action; as these are always centres of attraction. Popular lectures should be combined with practical demonstrations. Farm produce should be arranged in sufficiently large quantities to allow of being handled by those interested in them. If these conditions

can be attained, it is probable that a larger number of smaller shows are more useful than fewer shows on a larger scale.

It may be well to consider the whole question of agricultural publication together, so far as it is made for the purpose of introducing improvements into practice. In some parts of India, vernacular agricultural journals are issued, in some information which it is desired to spread is sent out in leaflets, in others again the general press is considered sufficient, and in Madras, an agricultural almanac in the various vernaculars is published. It is natural that in a matter like this the methods should differ, in each part of India, as the habits of the people vary. But whatever is done must be done well and must be written simply and in such language as the cultivators know. This latter point is of importance, for there is a danger that if a translation into the vernacular be made by a non-agriculturist, it will abound in phrases and words totally unintelligible to the ordinary cultivators. Again, any article, any leaflet, should be short, perhaps not exceeding a couple of pages, and should contain one definite fact or the description of a single process which it is desirable that the *ryot* should know and adopt, with illustrations whenever possible. The circulation of such material is a difficult point. A vernacular journal, which has to be paid for, is excellent if it only has a large enough circulation among actual cultivators. Such a circulation is not very easy to work up, and the agricultural department in the Central Provinces is the only one in India by which this has been really accomplished. Leaflets, being distributed free, can be spread more widely, but much of the distribution is useless. To avoid this they are, in Bombay, generally used (1) in connection with demonstrations of implements and methods, as for instance at shows; (2) in a limited area where special need has arisen. They are rarely distributed without at the same time arranging for the presence of an officer who can explain the nature of the improvement. Even with all these precautions, the extent to which such leaflets are really useful is still problematical.

Of course, it is possible to use the general vernacular press for publication of agricultural information. This is now very widely read, in by far the greatest amount, however, among the non-agricultural classes. Articles and material are however freely taken, and with a properly organised system of contribution, a considerable result might be expected to flow from its utilisation. If material is sent to the press for this purpose, no efforts should be spared to give the contributions a popular readable form, such as likely to command attention.

We have now considered most of the methods which have been adopted to ensure a wide extension of the knowledge of agricultural improvements. But there is one other to which I would like briefly to refer, namely, the training of the sons of cultivators in practical agriculture either on the farms of the agricultural department, or in special institutions. This has been carried on to a certain extent at Nagpur, and also in Bombay. The whole matter is, however, as yet in an experimental stage. Difficulty has been found in attracting the right class of student and those who come do not by any means always wish to go back to improve their own land. Where the right type of boys have been attracted, and where the course has been short and practical throughout, there have, however, been a good number of cases of success. But the whole question of the large applicability of such training is at present doubtful, and a very considerable amount of experiment will be required, and that under different conditions, before the best method is ascertained.

I might refer to many other methods which are of narrower application, but have been of service on particular cases. In certain cases lands have been colonised with good cultivators with very great effect on the character of the agriculture round about them ; in others, individual cultivators have been sent to new areas to teach the people round about them, their own methods, and so on. But again it must be recognised that there is no general method ; the conditions differ so much from place to place, and from province to province, that it is absolutely impossible to lay down anything more than indications of such

methods as have, in particular places, given successful results in the past.

In conclusion, there is sufficient information in hand now to indicate that, in spite of its peculiar difficulties, agricultural improvement is not impossible in any part of India. There is, however, no royal road,—the progress is, and must be for a long time to come, very slow. But, whatever methods be adopted, the actual process must be the same. To find the cultivators' real difficulties, to discover a practical and certain method of meeting those difficulties, to gain the confidence of the people; these all must precede any definite attempt at a propaganda. If the attempt is made to introduce so-called improvements without these necessary preliminaries, then not only will failure result but what confidence there may be will be undermined, and progress in the future will be made harder. Recognise the necessary order of events, try to satisfy the cultivator's needs and not something you imagine he ought to need, let your experiment be based on the requirements of the ryot, and success, though slow, will, if past experience be any guide, be sure.

PLATE I

THE POTATO MOTH.

PHTHORIMAEA OPERCULELLA.

(LITA SOLANELLA.)

Potato Moth.

Fig. 1. A potato plant showing injury caused by the larvæ.
,, 2. Moth resting on plant.
,, 3. Potato tuber showing evidences of caterpillar attack in the masses of excrement at the eyes. A cocoon on the tuber.
,, 4. Potato tuber cut open to show damage caused by caterpillar.
,, 5. Potato tuber showing the track of the caterpillar and the pupa.
,, 6. Young Larva.
,, 7. Imago, male.
,, 8. } ,, female.
,, 9. }
,, 10. Pupa.
,, 11. Adult larva.
,, 12. Eggs deposited at the eye of a potato tuber.

EXPERIMENTS IN THE STORAGE OF SEED-POTATOES.

By H. MAXWELL LEFROY, M.A., F.E.S., F.Z.S.,

Imperial Entomologist, Pusa,

AND

G. EVANS, B.A. (*Cantab.*),

Deputy Director of Agriculture, Northern Circle, Central Provinces.

In almost all parts of India where potatoes are grown, the tubers for seed have to be kept for a period of several months, usually during the rains, and during this time they are extensively attacked by disease and are consequently difficult to keep. There has been for years past a very large import of seed-potatoes from Italy, and there is little doubt that with these potatoes has come the potato-moth which is well established in Italy, Algeria, and other countries on the Mediterranean and which has been spread from there to Australia and other countries. The importation of the potato moth not only let loose an insect attacking the growing plant, but also one which immensely increased the difficulties of the potato-grower who stored his own seed; the pest attacks the stored potato freely, and has become well established in India where potatoes are grown.

To meet this pest it was necessary to devise a new method of storage; there must be no access of the moth to the potato in the first place, that is, the potato must be covered; it was soon found that storing the potatoes in a closed space or in bags was impossible owing to the enormous loss from disease and a long series of experiments was undertaken to determine exactly how the potato could be stored, so that it would not be attacked by potato-moth. These experiments were made at Pusa in 1908

and the results were applied in the Central Provinces as described below.

The potato-moth is shown in all its stages in Plate I; the moth is a small brown insect, which can be seen in hundreds flying about potato fields, and is abundant in houses in which potatoes are stored; the eggs are laid on the tuber, usually in an eye or on the under surface of the leaf of the growing plant usually at the angle of two veins; in the plant the caterpillar becomes a miner, making a blotch mine in the leaf (Plate I, fig. 1) or it bores in the shoots or leaf petioles, causing the shoot or leaf to wither; in the tuber the caterpillar tunnels in the potato entering at the eye and the presence of the caterpillar is shown by the black excrement grains on the outside of the tuber (Plate I, fig. 3). The full-fed caterpillar pupates in the tuber (Plate I, fig. 5) or if on the plant, in any convenient shelter on the leaves, stems or ground, in a light cocoon.

The whole life-history occupies about one month; a single cycle in March is as follows:

Egg laid	... 1st March
Egg hatched	... 7th ,,
Caterpillar full-fed and pupated	... 22nd ,,
Moths emerged	... 28th March to 3rd April
One moth that emerged on 1st April laid 25 eggs on	3rd April.
7 ,, ,,	7th ,,
9 ,, ,,	9th ,,
and died ,,	11th ,,

A generation then takes from four to five weeks only and the increase is rapid. The number of eggs laid varies, as many as 86 being laid in one case.

The pest is an introduced one and evidently if it could be prevented from breeding in the seed potatoes, it would be very much, if not entirely, checked, as it apparently has no other food-plants in India but potato.

THE PUSA EXPERIMENTS.

The experiments at Pusa were done with a view of testing the ways in which seed-potatoes could be stored absolutely out

of reach of the pest. If the moth cannot get access to the tuber, eggs cannot be laid, and if at the time of storing the tubers are freed of eggs, there can be no attack nor can the pest breed.

Lots of 25 seers each of seed-potatoes were taken, picked over to see they were sound and stored: one series was in baskets, another on mats or bamboo machans: for each series, a lot was stored in lime, lime and kerosene, lime and naphthaline, ashes, charcoal, sand, sand and kerosene, sand and naphthaline, sand and crude oil emulsion, neem leaves: for each of these again, one lot of tubers was untreated, others were dipped in crude oil emulsion (one pint in four gallons of water), rosin compound (stock solution), copper sulphate (cold saturated solution), lime water, lead arseniate (1 lb. in 4 gallons of water). There were check lots untreated, and three lots were treated with formalin at the suggestion of the Imperial Mycologist. The potatoes were examined at intervals and the rotten ones weighed and destroyed; they were stored at the end of May, the sound ones remaining on the 15th October sown. As some of the lots had wholly rotted, only those giving a definite percentage were sown; of these an equal quantity (five seers) of each was sown with the ordinary potatoes in the farm and the yield of each lot was obtained. The experiment showed certain general conclusions before the actual yields of potatoes were obtained and these were acted on in the Central Provinces. The tubers keep better on mats or on the floor than in a basket, bag or heaped up. The best medium is sand, or sand and naphthaline, the next best charcoal; lime was good but the actual yield of potatoes from seed stored in lime was small (this may have been simply experimental error). For dipping, lead arseniate, crude oil emulsion and copper sulphate are all good. Potatoes stored in ashes dry up at once and all perish in a short time.

The following table gives the results of those in which five seers out of twenty five were available at the end of the storage period: in this table, the method of storage is shown, then the amount rejected between June 1st and October 15th, the amount left on that date (the difference being evaporation from the

potatoes), the yield per acre based on the actual yield of the plot, and the total yield that would have been obtained from the whole amount of seed left from the 25 seers stored :

	Method of Storage.	Amount rejected.		Amount left on 15-X.		Yield per acre.		Yield from amount left.		
		S.	Ch.	S.	Ch.	Mds.	S.	Mds.	S.	Ch.
1.	In lime in basket	9	8	10	4	51	32	1	38	0
3.	Do. (19), Kerosene (1) in basket	10	12	9	7	44	12	1	24	0
5.	In *neem* leaves in basket	10	5	9	11	53	5	1	20	0
8.	In sand in basket	13	10	7	12	24	31	0	21	0
9.	Do. 20, Naphthaline 1, in basket	15	7	6	4	4	17	0	3	4
12.	Dipped in C.O.E. (1-32), in basket	10	3	7	11	35	8	0	37	0
13.	Ditto in lime in basket	8	13	11	12	58	17	2	27	8
15.	Ditto in sand in basket	9	5	11	6	81	0	3	18	0
20.	Dipped in Cu S O₄, in basket	12	1	6	5	68	16	1	24	0
21.	Ditto in lime in basket	8	8	10	10	72	15	2	35	0
23.	Ditto in sand in basket	9	3	10	6	63	16	2	18	0
24.	Dipped in lime sol., in basket	13	7	5	13	51	32	1	3	0
26.	Ditto in sand in basket	12	8	7	10	79	27	1	27	0
27.	Dipped in lead ars., 1-32, in basket	6	1	12	3	85	0	3	0	0
28.	Ditto 1-32, in lime in basket	7	6	11	15	33	21	2	28	0
30.	Ditto 1-32, in sand in basket	9	3	10	13	85	0	2	20	0
31.	Untreated in basket	9	0	8	2	65	3	2	0	0
32.	Ditto on mat	5	3	14	1	96	20	3	24	0
33.	Ditto do. in sand	5	8	15	5	108	0	4	20	0
34.	Ditto do. in sand and Naphth.	3	2	15	8	831	19	5	22	0
37.	Ditto do. in charcoal	3	2	13	12	102	28	3	36	0
39.	Dipped in lime sol., in sand	5	2	12	2	84	4	3	20	0
42.	Ditto formol, ½ %, 1 hour	7	0	10	8	49	5	1	[illegible]	[illegible]
43.	Ditto formol, 1 %, ½ hour	7	2	11	8	48	28	1	23	0
44.	Ditto formol, 3 %, 10 minutes	6	4	11	6	32	30	1	2	0

TRIALS IN THE CENTRAL PROVINCES.

OCCURRENCE :—The pest has been reported from a large number of different places in the Central Provinces.

The crop is an important garden crop, and in certain areas where the conditions of climate, water and manure supply are all favourable, it assumes considerable importance in the local economy of that tract. For several years it had been stated that the potato crop at Chhindwara had been steadily and rapidly decreasing in area and importance, and the cultivation of this particular crop formerly so profitable seemed threatened with extinction. It was decided to make an enquiry into the cause of this reported decrease in area in 1908, and in the spring of that year visits were made to Chhindwara and several other important potato-growing centres for this purpose. The damage was speedily found to be due to the ravages of the potato-moth (*Phthorimaea*

operculella) a pest which attacks the tubers in store, eating away the eyes of the potatoes and rendering them useless for seed purposes.

Enquiry showed that the pest was widely distributed throughout the north of the province as it was reported from such widely separated places as Marwara in the extreme north-east corner of the Province, Khamla in the south-west on the Berar border, Saugor in the Vindhyan tract, and in fact from nearly every place where potatoes are habitually grown. It occurs also in the Nilgiris, Dharwar, Belgaum, Poona and in Patna: it has not been found in Naini Tal or other places in the Himalayas, nor in any place north of the Ganges.

The pest seems to have been introduced quite recently. In Chhindwara, cultivators have been accustomed to store their seed so long as can be remembered, and as the place was very isolated before the railway was opened five years ago, no fresh seed was, as a rule, introduced. The arrival of the pest seems to coincide so far as can be ascertained with the introduction of the round white Italian variety from Poona owing to the well-intentioned efforts of one of the District Officers a few years ago, who hoped thereby to raise the quality of this crop, as the local "moolki" variety had much deteriorated and fresh seed was needed. Within the last three or four years, cultivators state that they have been unable to keep their seed, as it all goes rotten in May and June, whereas formerly only 25 per cent. of the seed stored was lost, and it mostly went rotten during the rains from the attacks of moulds and similar fungi.

In Saugor, growers say that the moth first appeared about eight years ago. Before this, however, when a change of seed was required, one or two potato cultivators were commissioned to purchase seed for all from Poona. They found, however, that the crop from Poona seed was of inferior quality and suffered from a disease which seems from all accounts to have been the ring disease (*Bacillus solanacearum*) which is still fairly prevalent there. As a result about eight or nine years ago, they decided to purchase their seed potatoes direct from the ship in Bombay, and the moth seems to have been introduced with the

freshly imported seed which comes from Italy and the South Mediterranean. Saugor potatoes are imported to many parts of the province, and the pest was probably spread by this means to other important potato-growing centres.

Remedial measures were accordingly decided on last year. The preliminary experiments described above had indicated that the only possible means of combating the pest was to destroy the eggs on the tubers before storing them for seed, by steeping them in some solution which would kill the eggs without injuring the germinating power of the seed and then to store the seed so treated in baskets covering them completely with sand or lime to prevent a fresh generation of moths from depositing more eggs on the seed tubers.

The three solutions, which had given the best results in these preliminary trials, were crude oil emulsion, copper sulphate and lead arseniate paste. The last was discarded at once as being impracticable. In addition to being difficult to obtain in outlying villages, it is a virulent poison and accidents were very likely to occur if it had been distributed, as villagers are not particularly careful in carrying out the details of experiments and do not fully study the most careful instructions.

Copper sulphate is now sold in many country bazaars in certain districts as a remedy for smut in juar, but it often contains ferrous sulphate as an impurity which is likely to injure the seed, and the crystals have also to be pounded and dissolved to make the solution, an operation requiring some time.

Crude oil emulsion therefore was finally fixed on as the most suitable remedy. The emulsion is simply poured into the requisite proportion of water and stirred with a stick and the solution is ready for treating the seed.

In the trials made last year, crude oil emulsion was used at Saugor, Chhindwara, Pachmarhi and Hoshangabad, and the copper sulphate was tried at Hoshangabad alone and only on a small scale.

An account of the operations undertaken at these places will prove of interest.

At Saugor the spring crop ripens at the end of April or beginning of May. As many of the cultivators, who are chiefly *Kachhis* by caste, as possible were assembled and the mixture made before them and its ingredients and action explained. One and a quarter pounds (equal to one pint) of crude oil emulsion, was weighed into a shallow tub containg 4 gallons of water and the contents stirred with a stick. Sand was found by the assembled community in a nullah close by. The cultivators stated that they had given up their old custom of storing potatoes for seed as they had found in the last few years that it was always completely destroyed in the early rains, whereas before the moth came, the loss in storage was approximately a quarter. Fifty cultivators, however, volunteered to try the experiment with quantities of seed varying from 175 to 10 lbs. The seed was carefully hand picked, steeped for five minutes in the solution, dried and stored in sand in baskets of two sizes, holding 25 and 50 seers respectively. The baskets were marked with a ticket giving the name of the tenant and weight of seed stored and each man was requested to keep a note of the date on which the tubers so stored were examined during the rains, as it was explained that the stored tubers should be examined at regular intervals and the rotten ones thrown out.

These last details as to examination during the storage period were not in every case properly carried out, but where regular examinations had been made the results were excellent. The tubers were stored on the 22nd and 24th May, and finally opened on the 4th to 6th September.

The results are shown below.

No. of cultivators.	Weight at storage in May.	Weight at opening in September.	Loss.	Remarks.
	lbs.	lbs.	Per cent.	
42	1,782	1,167	36	Examined at least twice during storage.
8	4[illegible]	131	69	Not examined after storage or lost from unavoidable causes.

In Chhindwara the potato crop ripens in March and potatoes were stored on the 7th of April 1909. The experiment was carried out by a large mali cultivator who is the head of all the malis in the neighbourhood, who besides cultivating a large area of garden land is also a member of the local Agricultural Association. He was also very sceptical of the efficacy of the treatment recommended, but when he understood that the cost of the treatment only came about one anna per maund and the tubers so treated remained good for culinary purposes he consented to a trial, and treatment and storage was undertaken before a large assembly of cultivators interested in the matter. The method employed was practically the same as at Saugor, but to simplify matters the solution was made a little weaker, one (whisky) bottle of crude oil emulsion being mixed with forty bottles of water in a galvanised iron tub and dried and stored as before. The mali examined his tubers three times during storage, rejecting the rotten ones. After the last examination in the middle of August, he kept the seed uncovered as he said that there was then no fear of the pest attacking the tubers.

The results at the time of planting on the 20th of September, *i.e.*, after $4\frac{1}{2}$ months storage are stated below :—

Weight at storage in April.	Weight at planting in September.	Loss.
lbs.	lbs.	Per cent.
300	150	50

No signs of the pest were seen in the tubers that remained in September. Before this pest was introduced cultivators always counted on a loss of about 40 per cent. on storage due to attacks of fungi, etc., during the rains as the period of storage is longer here than at Saugor. These results have met with the greatest satisfaction in Chhindwara, and the mali has applied for sufficient crude oil emulsion to treat the whole of the seed potatoes for the neighbourhood next year, while neighbouring villages have asked to have the method demonstrated. The cost

of potatoes in Chhindwara after the crop comes into the market is thirty seers to the rupee, while the cost of seed potatoes in September-October at the time of planting is no less than ten seers per rupee from which it will be understood that this remedy, if widely adopted, will effect very considerable saving.

In Pachmarhi, cultivators could not be persuaded to carry out trials, but demonstrations were made in the public garden where it was necessary to store the seed from a crop of English potatoes which it was desired to propagate. The methods employed were similar to the above-mentioned instances, the strength of the crude oil emulsion being 1 pint in 4 gallons of water. Tubers were stored for nine weeks only and were opened out for planting in the first week of July.

Results are tabulated below :—

Weight of tubers stored.	Weight [illegible]	[illegible]	
lbs.	lbs.	[illegible]	
464	425	8·[illegible]	Treated and stored.
70	[illegible]	28·[illegible]	Check experiment. Tubers not treated or stored.

When the potato moth pest is absent, little loss occurs in Pachmarhi during the hot weather months, and the main loss is caused by fungi and moulds in the rainy season months. The godown in which the experiment was carried out was cleaner and afforded less refuge for moth than the ordinary cultivator's shelter and the loss from moth during the hot weather is probably more than 30 per cent.

On the Hoshangabad Farm last season trials on a small scale were made to ascertain the most convenient method of treating seed potatoes. So far as they went, the trials indicated that the loss when copper sulphate is used as the steeping solution was comparatively greater than when crude oil emulsion was used. On the other hand, lime gave slightly better results than sand as a covering material, but taking into consideration the cost of lime in most parts of these Provinces and its inferior and uncertain quality, there seems little doubt that sand is the

most convenient and practicable material with which to cover the seed tubers after treatment.

For storing small quantities of seed-potatoes ordinary bamboo baskets are very convenient, but when large quantities of seed have to be handled the preliminary cost is rather excessive and the space required is great. These and other little difficulties connected with the use of baskets were pointed out by big growers at Saugor and Chhindwara. At Saugor two gons (1 gon = $3\frac{1}{2}$ mds.) were steeped in crude oil emulsion in the ordinary way. A bamboo mat was placed on the floor of the godown and covered with sand, a layer of potatoes was then laid down and covered with sand and another layer on the top, the whole being finally covered with sand. These tubers were stored for $3\frac{1}{2}$ months, but unfortunately were not looked at regularly and the upper tubers also got uncovered as care was not taken to keep the sand properly over them.

The results are, however, encouraging as a considerable saving of seed was effected and with a little experience a modification of this method should prove successful.

Weight at storing in May.	Weight remaining in September.	Loss.	Remarks.
lbs.	lbs.	Per cent.	
560	18[illegible]	[illegible]7	Stored on bamboo mat lying in sand.

The natural wastage on storage in Saugor is about 25 per cent., and in this case the top layer of tubers suffered from attacks of the potato-moth caterpillar, as the protecting layer of sand was in places removed through carelessness.

In conclusion, it may be asserted that the results obtained are distinctly encouraging for one year's demonstration. The remedy is simple, cheap and efficacious and when potato-growers begin to realise the necessity for completely covering their seed with sand and regularly going over their stock in the rains in order to reject rotten tubers and prevent the spread of fungi, there seems little doubt that they will be able to combat this pest successfully.

THE EFFICIENCY OF THE "HADI PROCESS OF SUGAR MANUFACTURE.

By G. CLARKE, F.I.C.,

Agricultural Chemist to the Government of the United Provinces,

AND

S. C. BANERJEE.

THE experiments recorded in this article were undertaken to test the efficiency of the method of sugar boiling introduced some years ago by S. M. Hadi, Khan Bahadur, Assistant Director of Agriculture, United Provinces, and known as the "Hadi Process." Certain technical improvements on the old methods have made it very popular among land-holders, and others desiring to produce sugar directly from juice in an area with a limited supply of cane.

The process is too well known to need a detailed description in these pages, and has been fully described in Bulletin 19 of the Department of Agriculture, United Provinces. For the benefit of those who are not able to obtain the original memoir, it may be mentioned that it consists essentially in boiling the juice in a series of three open pans, arranged to work continuously over a furnace, in such a manner as to facilitate economy of fuel, and to produce the gradual heating necessary for the modified methods of clarification introduced by the inventor.

These modifications consist in adding small quantities of dilute Sodium Carbonate solution and the juice of *Hibiscus esculentus* to the gradually warming juice, and removing the scum by hand. It is an essential feature of the process, as at present practised, that lime is not used during the clarification. The use of lime has been advocated by many as likely to reduce the loss of sugar, and comparative trials on a large scale with limed and unlimed juices will shortly be undertaken by this Department.

The first thing to determine is the actual efficiency of the process as at present worked, *viz.*: How much of the sucrose that goes into the factory in the juice is obtained in a merchantable form in the first and second sugar, how much of it goes into the molasses and scum, and how much of it is inverted and destroyed during the process of the manufacture. The work of the department this year was confined to attempts to obtain satisfactory and reliable answers to these questions.

The factory selected by the Assistant Director of Agriculture for the test was situated at Baraon in the Karchana Tahsil of the Allahabad district. It belonged to Rai Ragho Prasad Narain Singh Bahadur, Thakur of Baraon, and to this gentleman we desire to offer our most hearty thanks. Without his help and co-operation the work could not have been carried out.

The factory was provided with a 3 roller mill by Messrs. Harris & Co. of the Napier Iron Works, Madras, driven by a 9-horse-power Hornsby oil engine, and capable of crushing 20 maunds of cane an hour. The rollers were 12 inches in diameter and 18 inches long. A steam driven centrifugal was in the course of erection, but it was not used for the experimental work. The latter was carried out with hand-driven machines, 18 inches in diameter, described in Bulletin 19 of the United Provinces Department of Agriculture.

The efficiency of factories using the process will vary within certain limits: the skill of the sugar boilers in this as in other processes of sugar manufacture is the important factor. There is every reason to believe that this factory is a typical one and that the figures obtained indicate an efficiency that can usually be expected.

The details of the actual working of the process were not interfered with, and were precisely what they would have been, if the experimental control had not been in progress.

The juice as it came from the mill was weighed, and sampled. In each sample the amount of sucrose, the amount of glucose,* and the specific gravity was determined by the methods, described

* The term "glucose" used in this article includes all reducing sugars.

by the authors in Bulletin 13 of the Imperial Department of Agriculture.

The juice was then taken into the evaporators and boiled into 'rab' (massecuite). The scum, removed during purification, was, after draining, weighed, sampled, and analysed at the end of each day's work.

The warm massecuite from the evaporators was stored in ghurras (bottle-shaped earthen vessels holding about 60lbs. of rab) until it was ready for centrifugating. The length of time that should elapse before massecuite produced by this process deposits a maximum amount of crystals varies, but it is considered by those experienced in the work not to be under 10 days.

The experimental boiling began on January 16th and ended on January 26th. The centrifugation of the first samples of massecuite commenced on January 28th, and continued until February 5th, approximately 500lbs. being worked up daily. Each day's yield of 1st sugars was air-dried, weighed, and a representative sample sent to the central laboratory for analysis.

The molasses from the 1st sugars were boiled into second massecuite, stored in ghurras, and allowed to stand 3 weeks before centrifugating. Finally, the second sugar and the molasses from the second massecuite were weighed, sampled, and analysed.

When massecuite is worked up into sugar, the ghurras in which it is stored are broken, and the massecuite scraped from the broken pieces. The scraping is, however, never complete. The small loss from this source was determined by weighing the broken ghurras, taking a representative sample, and estimating the glucose and the sucrose in it.

The operations recorded above afford the necessary data for determining the efficiency factor of the boiling process.

The investigation of the efficiency of the mill as indicated by the percentage extraction was not undertaken. It was deemed inadvisable to impose more quantitative experimental work on the staff than could reasonably be carried out. The efficiency of the mill is of course a most important point in the economical working of the factory and should be determined whenever a new mill

is erected, but it does not affect the question of establishing an accurate control of the boiling process.

The composition of the raw juices used during the 10-days experimental boiling is given in Table I.

TABLE I.

Composition of the Raw Juice.

No.	Weight.	Sucrose.	Sucrose.	Invert Sugar.	Invert Sugar.	Glucose Ratio.	Specific Gravity.	Total Solids.	Purity co-efficient.
	lbs.	Per cent.	lbs.	Per cent	lbs.			Per cent.	
1	689·0	15·53	106·8	1·35	9·3	8·7	1·0814	19·6	79·1
2	712·0	14·50	103·8	1·43	10·2	9·8	1·0780	18·8	77·0
3	722·0	13·63	98·4	1·56	11·2	11·4	1·0733	17·8	76·5
4	781·0	13·81	107·8	1·59	12·4	11·5	1·0747	18·1	76·3
5	724·2	15·00	108·6	1·50	10·8	10·0	1·0797	19·2	78·1
6	691·0	14·82	102·4	1·40	9·7	9·4	1·0788	19·0	78·0
7	631·5	15·20	95·9	1·33	8·4	8·7	1·0794	19·1	79·5
8	665·0	14·91	99·1	1·27	8·4	8·5	1·0790	19·0	78·4
9	648·2	14·73	95·4	1·33	8·6	9·0	1·0785	18·9	77·9
10	639·5	15·51	99·1	1·21	7·7	7·8	1·0811	19·5	79·5
11	1,106·5	16·47	182·0	1·10	12·5	6·8	1·0826	19·8	83·0
12	1,483·7	13·40	198·8	1·23	18·2	9·1	1·0685	16·7	80·0
13	700·2	14·00	98·2	0·75	5·2	5·2	1·0676	16·5	84·8
14	740·0	14·60	108·7	0·65	4·8	4·4	1·0710	17·3	84·2
15	967·0	14·31	138·3	0·78	7·5	5·4	1·0697	16·9	84·6
16	724·7	14·50	105·0	0·81	5·9	5·5	1·0705	17·1	84·7
17	976·5	14·62	142·7	0·94	9·2	6·4	1·0724	17·5	83·5
18	896·0	15·19	136·1	1·10	9·8	7·2	1·0753	18·4	82·5
19	723·0	14·80	107·6	0·78	5·6	5·2	1·0739	17·9	83·1
20	742·0	15·20	112·7	0·82	6·0	5·3	1·0756	18·3	83·0
21	753·5	14·46	108·9	0·82	6·2	[illegible]	1·0720	17·7	81·6
22	744·0	15·61	116·1	0·89	6·6	5·7	1·0773	18·7	83·4
23	1,391·5	14·84	206·5	0·76	10·6	5·1	1·0730	17·9	82·9
24	495·7	14·75	73·1	0·82	4·0	5·5	1·0732	17·8	82·8
25	726·0	14·88	108·0	0·75	5·4	5·0	1·0744	18·0	82·6
26	986·5	14·83	146·3	0·76	7·5	5·1	1·0744	[illegible]	82·3
27	736·0	16·07	118·3	0·81	5·9	5·0	1·0795	19·2	83·7
28	740·0	16·21	119·0	0·82	[illegible]	[illegible]	1·0796	19·2	84·4
29	747·0	15·91	118·8	1·15	8·6	7·2	1·0801	19·3	82·4
30	745·0	15·58	116·1	1·29	9·6	8·2	1·0800	19·5	80·7
31	742·0	15·43	114·5	1·45	10·7	9·3	1·0800	19·3	79·9
32	743·5	16·69	124·1	0·70	5·2	4·1	1·0827	19·9	83·8
33	752·2	16·25	122·2	0·70	[illegible]	4·3	1·0803	19·4	83·7
34	753·5	17·13	129·1	0·87	6·5	5·0	1·0857	20·5	83·5
35	985·5	16·83	165·6	0·87	8·6	5·1	1·0828	19·9	84·5
	28,013·9	15·12	[illegible]	1·02	288·1	6·6	1·0765	18·5	81·7

The sucrose varies from 13·40 % to 17·13 % and glucose from 0·65 % to 1·59 %.

It is a well-known fact that the amount of crystallisable sugar obtainable from massecuite is very considerably influenced by the quality of the juice from which it is made. A comparatively small increase in the amount of glucose in the juice

causing a considerable diminution in the quantity of crystalline sugar, obtained from the massecuite, and a proportionate increase in the amount of sucrose lost in the molasses.

The experiments this year afforded an opportunity of practically demonstrating this important point. The examination of the raw juices (Table I) showed that the earlier samples were poorer in quality as sugar producers than those examined towards the end. The actual percentage of sucrose was not much less, but they contained larger amounts of glucose and other solids in solution, which prevent sucrose from crystallising: that is to say, they had high glucose ratios and low purity co-efficients.

The method of storing rab in small ghurras enabled us to centrifugate separately the massecuite from the different samples of juice, and to correlate the yield of sugar and molasses with the composition of the juices.

TABLE II.

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
16-1-09	[illegible]	[illegible]	[illegible]	[illegible]	1·44	[illegible]	77·8
16-1-09 / 17-1-09	[illegible]	28·7	71·3	14·07	[illegible]	[illegible]	78·0
17-1-09 / 18-1-09	[illegible]	[illegible]	[illegible]	[illegible]	1·21	[illegible]	[illegible]
19-1-09	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
20-1-09	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	84·1
[illegible]	[illegible]	36·7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	36·8	[illegible]	14·84	[illegible]	[illegible]	82·8
[illegible]	[illegible]	[illegible]	[illegible]	15·83	1·1	[illegible]	82·4
[illegible]	[illegible]	[illegible]	[illegible]	16·72	[illegible]	[illegible]	[illegible]

Table II shows the percentage of 1st sugar and molasses in the massecuite, and the average composition of the juice from which it was made. Low yields of crystalline sugar always accompany high glucose ratios and low purity co-efficients.

To take two examples, the juice boiled on the 16th & 17th January contained 1·46 % of glucose. Its glucose ratio was very high, *viz.*, 9·9 and its purity co-efficient low, *viz.*, 78. The massecuite yielded 28·77 % of sugar crystals when it was

centrifugated. The sugar was badly grained and difficult to handle. The juice boiled on 22nd January contained 0·76 % glucose, the glucose ratio was much lower 5·1, and its purity co-efficient high, *viz.*, 82·8. The massecuite yielded 36·8 % of crystalline sugar, nearly 8 per cent. more than that obtained from the poorer quality juice. The percentage of sucrose in both juices was almost the same = 14·67 in one, and 14·83 in the other. This may make all the difference between profit and loss in working a factory.

The canes of Northern India contain a higher percentage of glucose and impurities in solution than those of other countries, and the results contained in Table II bear out the author's contention in a previous publication, that the first efforts to improve the cane of these provinces, from a sugar manufacturer's point of view, should take the form of selecting and cultivating varieties, which ripen uniformly and at the required time, and which yield a pure juice, *viz.*, one with a high purity co-efficient, and a low glucose ratio. This is just as important when sugar is made indirectly from gur, as when it is made directly from cane.

The weight and composition of the products,—1st and 2nd sugars—final molasses—1st and 2nd massecuite and the ghurra waste are given in Table III. The weight and composition of the scum in Table IV.

TABLE III.

Composition of 1st Sugar.

No.	Weight.	[illegible]	[illegible]	[illegible]	[illegible]
	lbs.	Per cent.	Per cent.	lbs.	lbs.
1	53·5	92·76	1·16	49·62	2·22
2	152·5	96·44	1·10	147·07	1·67
3	77·0	91·18	3·43	70·20	2·64
4	164·5	94·24	[illegible]	155·02	3·42
5	96·5	93·50	[illegible]	90·22	[illegible]
6	90·5	93·61	3·06	84·71	2·76
7	162·0	96·54	1·41	156·39	2·28
8	200·5	96·70	1·16	193·88	2·32
9	225·0	95·01	1·59	213·77	3·57
10	125·0	94·85	2·32	118·56	2·90
11 & 12	431·0	95·93	1·34	413·45	5·77
	1778·0	95·16	1·79	1692·92	31·84

Composition of 2nd Sugar.

1	753·5	86·89	6·32	654·7	48·4

Composition of Final Molasses.

1	2312·5	35·92	20·30	830·6	469·4

Composition of 1st Massecuite (1st Rab.)

1	5205·5	67·86	10·4	3532·4	541·4

Composition of 2nd Massecuite (2nd Rab.)

1	2530·5	56·68	19·89	1439·4	505·1

Composition of Ghoorni Waste.

1	802·75	6·03	1·91	48·4	15·3

TABLE IV.

Composition of Scum.

No.	Weight.	Sucrose.	Glucose.	Sucrose.	Glucose.
	lbs.	Per cent.	Per cent.	lbs.	lbs.
1	28·2	14·60		4·1	
2	64·5	16·80	...	10·8	
3	39·8	12·08	...	4·8	...
4	61·5	13·76	2·50	8·4	1·55
5	49·7	24·32	4·92	12·1	2·44
6	105·0	14·74	1·56	15·5	1·63
7	45·0	14·82	1·74	6·6	0·78
8	81·0	15·19	1·11	12·3	0·89
9	129·0	16·46	1·28	21·2	1·65
10	112·5	19·92	1·98	22·4	2·22
11	175·0	23·20	2·23	40·6	3·90
12	147·0	16·50	1·60	24·3	2·35
13	44·0	13·48	1·04	5·9	0·45
14	52·5	14·14	1·69	7·3	0·88
	1134·7	17·32		196·6	

28014 lbs. of juice yielded 1778 lbs. of air dried 1st sugar.
753·5 lbs ,, 2nd sugar.
2312·5 lbs. of molasses.

This expressed as percentage of the juice is—

Air dried 1st sugar ... 6·3 of total juice.
Air dried 2nd sugar ... 2·7 ,,
Final molasses

The percentage of juice extracted by the mill used at Baraon was not determined at the time of the control of the boiling process for reasons already stated. Experiments have indicated that not more than 60—65 per cent. of juice can be extracted. The yield of sugars and molasses expressed as percentage of cane, on the assumption that the juice represents 65 per cent. of the cane worked, is as follows :—

Air-dried 1st sugar	... 4·10	per cent. of the total weight of cane.
Air-dried 2nd sugar	... 1·76	" " "
Molasses	... 5·35	" " "

The total amount of merchantable sugar is slightly less than 6 per cent. of the total weight of cane.

A résumé of the yields and losses of sucrose is given in Table V.

TABLE V.

Total juice boiled in lbs.	Total lbs. Sucrose in juice.	Total lbs. Sucrose 1st Sugar.	Total lbs. Sucrose in 2nd Sugar.	[illegible]	[illegible]	[illegible]	[illegible]
25014	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

The yields and losses of sucrose calculated as percentages of the total sucrose (4235·9 lbs.) that passed into the evaporators in the juice are as follows :

Per cent. of total sucrose in	1st sugar	...	39·9
"	"	"	2nd sugar	...	15·5
"	"	"	Final molasses	...	19·6
"	"	"	Scum	...	4·7
"	"	"	Ghurra Waste	...	1·1
Per cent. total sucrose inverted and destroyed			...	19·2
		Manufacture	...	100·0

The yields and losses of sucrose calculated as percentage on the total weight of juice worked up are given below :—

Sucrose in 1st sugar per cent. juice		...	6·05
,,	2nd sugar ,,	...	2·35
,,	Molasses ,,	...	2·96
,,	Scum ,,	...	·60
,,	Ghurra Waste ,,	...	·17
Sucrose in inverted and destroyed in the process of manufacture per cent. juice		..	2·90
Total Sucrose per cent. juice		...	15·12

For every 100 lbs. of sucrose that goes into the factory in the juice, 55·4 lbs. is obtained in merchantable form in the final sugars, 39·9 in the 1st sugar and 15·5 in the 2nd sugar. The efficiency factor of the boiling process is therefore 55·4.

The principal loss is by inversion and destruction of sucrose during the boiling of the juice into 1st massecuite, and the 1st molasses into 2nd massecuite. This loss cannot be determined directly, because not only is the sucrose inverted, but a considerable portion of the invert sugar is caramelised and charred, and cannot be traced analytically. The best way to estimate the loss by inversion and destruction is to determine, with the greatest accuracy possible, every other loss, and to take the difference figure. This is comparatively easy in a plant handling small quantities of juice, where losses of any magnitude such as spilling the juice on the way to the pans, can be prevented. The figure 19·2 representing percentage of total sucrose lost by inversion and destruction during boiling includes the small mechanical losses, which occur during the carriage of the juice from the mills, and the removal of the finished sugar from the centrifugating machines. These are very small, and certainly do not exceed 1 or 1½ per cent.

The amount of inversion and loss during evaporation is large, and is, to a certain extent, the result of using raw and acid juices. The efficiency of the process would be increased, if some suitable

method of neutralising the acids of the juice could be devised, although boiling sucrose in open pans would always give rise to considerable decomposition.

Good results have not been obtained by workers in these provinces by neutralising the juice with quick lime; dark massecuite and low quality sugar are said to be produced. It is possible that this is due to using very much more lime than is necessary for neutralisation. Further experiments are, however, desirable before a final decision is given on the merits of liming.

Sodium carbonate, which is employed at present, to partly neutralise the acids is unsuitable, because the sodium salts of the neutralised acids are left in solution, hinder the crystallisation of the sugar, and increase the amount of molasses.

It is suggested that finely ground carbonate of lime would be a suitable neutralising medium, because it would not form the objectionable compounds with sucrose, that cause the dark-coloured massecuite, when a slight excess of lime is used. There would, moreover, be no danger in using excess of it, as it is insoluble in water. The only disadvantage would be the filtering through cloth, necessary as the juice passes from the clarifier to the evaporator.

The sucrose lost in the scum amounts to nearly 5 per cent. This loss is avoidable, and could be reduced to certainly not more than one per cent. by the use of suitable filtering apparatus.

It is difficult to obtain figures of the efficiency of other processes, to compare with those given in this bulletin. These are not generally published by such factories as obtain them. As far as the authors are aware, none have been published in India.

The authors have been able to refer to comparative results of efficiency published in the West India Bulletin,* and to the factory results of 10 seasons' work in Java.†

* Central Factories for the West Indies by W[illegible] D[illegible], [illegible], West India Bulletin, Vol. I, page 14 (The authors are indebted to Mr. [illegible] for the loan of this literature).

† Statistics of Factory results on a number of Java Sugar Estates by H. C. Prinsen Geerlegs. International Sugar Journal, No. 127, Vol. II (July [illegible]) 324.

These indicate the results achieved by other processes, and are compared with those obtained at Baraon in Table VI.

TABLE VI.

Comparison of the efficiencies of different processes of boiling and clarification.

Sucrose recovered per 100 Sucrose in cane in	Hadi Process [illegible] (Average)	West Indian Muscovado Process [illegible]	Hawaiian Factory Triple effect [illegible] evaporation [illegible]	West Indian Central Factory Evaporation [illegible]	Results of 55 factories in Java, 1907.
First Sugar	[illegible]	67·75	89·91	72·4	89·91
Second Sugar	17·5			9·9	
Molasses	19·6	17·75	[illegible]	12·9	9·25
Inverted and destroyed in manufacture	19·2	14·5	3·55	4·6	
Scum and waste	5·8		1·18	1·2	0·84
	100·0	100·0	100·0	100·6	100·0
Efficiency factor per cent. (total Sucrose recovered).	55·4	67·75	89·91	82·3	89·91
First Sugar recovered per cent. cane.	[illegible] Pol. [illegible]	7·15 Pol. [illegible]	10·4 Pol. [illegible]	[illegible] Pol. [illegible]	10·09 Pol. 97·8
Second Sugar recovered per cent. cane.	1·76 Pol. [illegible]		[illegible] Pol. [illegible]	1·26 Pol. [illegible]	
Total Sugar	[illegible]	7·15	[illegible]	[illegible]	[illegible]

These figures are not brought forward to minimise in any way the important part played by the process under review in the revival of sugar making in India. They indicate, however, the kind of competitors that have to be faced in developing the industry in this country. The efficiency of open pan boiling employed in the Hadi process cannot hope to approach that obtained with modern plant employing vacuum evaporation, but it should not be criticised too severely from this point of view alone. It must be remembered that it enables sugar to be manufactured in places with a limited supply of cane where

without it none would be made. The point to be careful about is to see that it is confined to its proper sphere, that is, working up small quantities of juice; and not employed in large factories where other forms of plant would be more efficient

It will be seen from Table VI that factories in other countries with the most improved and up-to-date methods of manufacture are stated to be able to recover more than 80 per cent, of the sucrose in the juice as a merchantable commodity. In the Java results for the 10 years 1899—1908, already referred to, the average was 89·2 with a juice of purity varying from 83·3—88·66.

These factories have the advantages of experienced and skilled management, and the latest machinery; and they work on juice of somewhat higher purity than are produced in this country. It is not likely that factories established in India would show such a high efficiency continuously, at least not until considerable improvements have been made in the purity of the juice, and its glucose content lowered. An efficiency of 70—75 per cent. could, however, reasonably be expected with the juice at present available.

It is generally conceded that large central factories, of the type erected in Java and Hawaii, to work directly from juice, have little chance of success in Upper India; one of the reasons being the scattered distribution of the cane crop.

There is, however, no reason as to why a small and efficient plant working from 100—200 acres of cane season, and employing vacuum evaporation and improved methods of clarification, should not be a success. The difficulty at present seems to be as such a plant has not hitherto been required. None are on the market, and consequently the initial cost of designing and erecting it would be somewhat prohibitive; moreover, there are no trained men available at reasonable wages to work it.

One of the most useful lines of work that could be taken up by the Agricultural Department would be the experimental working of a plant of the type indicated above, and, if successful, training men to manage it.

The authors desire to take this opportunity of thanking their colleagues, Khan Bahadur S. M. Hadi and Syed Zamin Husain, for the valuable assistance afforded in obtaining the results recorded in this article.

AGRICULTURE IN THE KACHIN HILL TRACTS, BHAMO DISTRICT.

By E. THOMPSTONE, B.Sc.,

Principal, Agricultural College, Burma.

I. *Area, Situation and Elevations.*—The Kachin Hill Tracts of the Bhamo District comprise an area of about 2,000 square miles, bordering upon the Chinese frontier, to the north of the Shan States—between the degrees of latitude 24·45 and 25·30, and of longitude 97° to 98°. The whole of the tract is very hilly—apart from the terraces, the areas of level or nearly level land being very small indeed and confined to very small patches scattered here and there in the deep valleys throughout the hills; or to somewhat larger areas bordering upon the large streams or rivers; which, for a great part of their course, however, flow rapidly between high banks or through deep gorges.

The elevation above sea-level runs from about 500 feet to 6,000 or 7,000 feet; some of the highest points rising somewhat abruptly to as much as 8,000 feet.

II. *Climatic Conditions.*—The rainfall varies from about 130" to 197". The variation of temperature from place to place according to the elevation, is very considerable. Even in the lower elevations the winter temperature is low, whilst frost and strong winds are very common in the higher regions. In sheltered valleys, frost often occurs as low as 2,500 feet elevation.

III. *Soils.*—The surface is frequently covered with rocks and breccia, and the soil for the most part is of a poor light, sandy nature, containing little or no organic matter and of a reddish colour. The slopes are generally very steep, though they vary considerably, and in the absence of vegetation the surface soil with any small amount of organic matter it may contain, is

easily washed away. These steep slopes (often rising at an angle of 80 degrees or even 90 degrees from the horizontal), as well as the more gentle ones, are largely under "Taungya" cultivation, which is carried out under what appear to be almost impossible conditions. One kind of soil apparently differing from the above only in being of a much brighter, rusty red colour appears to possess exceptional fertility, being capable of producing 8 or 9 crops of paddy in successive years; after which it is left fallow for another period of 8 or 9 years; not on account of any great exhaustion of the soil, but because, after 8 or 5 crops, the paddy is said by the cultivators to develop a bitter taste. This kind of soil exists on what is known as the Palaung ridge, and on many of the similar less elevated ridges and slopes towards the east of tract near the Chinese frontier.

The soil in some of the valleys is very rich, of a dark brown colour and easily worked, but these valleys are nowhere very wide and the area of such soil is strictly limited.

IV. *The People and their Habits of Living.*—(Information obtained largely from D. W. Rae, Esq., E.A.C., Assistant Superintendent, Kachin Hill Tracts). There are many different tribes of "Kachins" or "Chinpaws" as they call themselves, but their habits of living and systems of agriculture are much alike and may be described as one. There are, however, living in the same district, other tribes who practise somewhat different methods. These latter live in villages apart from the Kachins; but from our point of view, only one of them is of any great interest, namely, the "Yawyin" or "Lishaw" tribe, a mountainous race, inhabiting for the most part the highest ridges and practising a most destructive system of taungya cultivation.

The Kachins are supposed to have been in possession of these hills for a period of less than 100 years, but previous to that time the "Palaungs," a less warlike race driven out by the Kachins, obtained a livelihood largely by taungya cultivation, in much the same way as the latter race does at the present day. It is not known for what period the Palaungs held possession of the country, hence it is impossible to say how long this system of

agriculture has here been carried out, but it seems probable from the appearance of the country and the growth of vegetation that it has been continued for several centuries. The Kachin builds himself a comparatively large house with a low grass-thatched roof, the eaves of which almost touch the ground. The roof generally projects at both ends beyond the living room or rooms of the house, and under the shelter so formed his cattle, fowls and pigs are enclosed or find protection from the elements. These permanent houses built on flat or levelled pieces of ground are roughly grouped together in small villages in suitable, sheltered, accessible places, where there is a good water-supply on the sides of the hills, and a village or house is rarely removed.

The bread-winner of the family, however, does not usually live here throughout the year. At the time of cutting and burning his taungya (always within the jurisdiction of his village but often at a long distance from it), he builds for himself a small hut in which he lives until his crop has been harvested, after which he returns to his village for the remainder of the year.

METHODS OF CULTIVATION.

I. *Taungya Cultivation* is practised by all the hill tribes and is the chief means of subsistence, but the Kachin alone appears to carry out his cultivation in a systematic manner. The area at the disposal of any Kachin village is often roughly divided into the requisite number of blocks according to the length of the rotation—each block being cultivated in turn.

Taungya cutting takes place during the dry weather about the month of March. The cultivator, after cutting down the trees, shrubs and other growth, clears a strip all around the area to act as a fire-guard to the adjacent areas and sets fire to the dried brushwood. The trees are not, as a rule, cut off quite near the surface of the ground, but stumps projecting 2 or 3 feet above ground are left. Very little actual cultivation is carried out and cattle are seldom used for this purpose, though on the more accessible slopes a rough harrow drawn by buffaloes or bullocks is made use of. The seed is usually sown during the early rains by

dibbling into small "pockets" of soil loosened by the aid of a hoe or mamootie—the distances apart of the pockets and the number of seeds varying with the different crops sown. The after-cultivation is also very slight and consists of rough weeding and loosening of the surface soil by means of the hoe or mamootie. In reaping a good deal of the straw is left as stubble on the ground.

Rotations in Taungya Cultivation.—No definite rules of rotations are followed, but it is very seldom that more than two crops are taken off a piece of land before it is again allowed to lie fallow. A common practice at elevations below 2,500 feet is to grow the first year a crop of cotton and the second year a crop of paddy. The land is then allowed to return to its jungle state during a period varying from 7 to 12 years. At elevations above 2,500 feet, one crop only is taken, usually paddy or maize, though in favourable aspects two crops may be taken. When left fallow, the taungyas in some places rapidly become clothed with small trees and shrubs, but in other parts, especially at the higher elevations, this does not take place; but there arises instead, a dense growth of bracken and coarse grass, which not only prevents the seedlings of trees from becoming established, but, as it dies off each year and becomes very dry, causes enormous areas to be annually burnt over. This state of things exists over large areas on many of the higher hills, especially those formerly occupied by the Yawyins. As a means of preventing this a few villages in the more densely populated parts of the district have adopted the plan of sowing the seeds of trees or shrubs along with their crops of paddy. The seed selected is that of quick-growing species of Alder (*Alnus nepalensis*), called by them "Maibao," which reproduces very rapidly indeed and will grow specially well at these high elevations. This plan not only ensures a rapid covering of the ground but tends to shorten the rotation, which to the Kachins is of no small importance as the population becomes more dense.

One other rotation previously remarked upon should be here noted, namely, the 16 to 18-year rotation carried out on the Palaung ridge and other places near Lwejé. This is believed to

be rendered possible by the particularly fertile soil which, though it differs very little in appearance from most other soil of the region, is said to be capable of producing 8 or 9 crops of paddy in succession, after which the grain becomes bitter and unfit for food. After a rest of 8 or 9 years during which only tall, coarse grasses seem to flourish, the land becomes again suitable for cropping. If the cultivators' statements are correct, this will be an interesting problem for investigation. Most of the Eastern slopes on which this occurs are absolutely devoid of trees or shrubs, but are burnt off and cultivated in the same way as ordinary taungyas, except that a plough is usually made use of. Cultivation is begun in good time and is well carried out.

With the Yawyins or Lishaws the method is somewhat different. Taungyas are often burnt without previous cutting, *i.e.*, with the trees standing upright, and no fire-belt is made for the protection of surrounding areas. They do not adopt any method in their cultivation, but each man appears to burn his taungya when and where he feels inclined. The result of this is, that enormous areas not required for sowing are often carelessly burnt down, and to this system is generally attributed the great damage to forests done within the region occupied by this tribe. Enormous areas are now covered with bracken and coarse grasses as already described. Though the area occupied is large, the tribe is a small one and consists of some 18 small villages, and a total of 62 families. As they generally occupy only the highest and steepest parts of the hills, they do not, as a rule, grow any cotton or much paddy, but confine themselves largely to the cultivation of maize and a kind of small grained buck wheat called "Shari Mam."

In the Lapye Kha valley the following rotation is often practised, *viz.*, the first year after burning a "Ya," maize is sown, the second and third years "Shari Mam," the fourth year opium, after which it is left fallow at least 10 years. If the soil happens to be good, the rotation may be lengthened by growing opium for 3 or even 4 years in succession before the land is left fallow.

II. *Terrace Cultivation*.—In some parts the area under terraces is considerable, and this system of cultivation, which is being encouraged, seems to be growing in favour among the villages possessing land which is not too steep. Some of the finest valleys are now terraced almost throughout, and in many places along the border they are cultivated by the transfrontier tribes or by the Chinese. In the lowest parts of the valleys the soil on these terraces is often extremely fertile; but in this region such soil is very limited and by terracing the steeper hill-sides, where the surface soil is extremely thin, the subsoil is exposed with the result that for a long time very poor crops only are obtainable. The labour is also very great and consequently the lazy Kachin seldom undertakes the work unless forced by necessity to do so. Moreover, "the Taungya" is necessary for certain "Nat" festivals or ceremonies; hence terrace cultivation is unlikely to entirely replace this method.

Paddy is the only crop grown on terraces to any great extent. The cultivation is generally done by cattle, though on narrow terraces it often has to be done by hand. It is often irrigated from some small stream or freshet running near by. The yield—except in the bottom of the valleys—is generally very poor—often on the newly-formed terraces not more than the yield from a taungya. In several places the figures obtained were 5 to 6 baskets of coarse paddy per acre. The paddy called "Tagu" grown on the terraces is generally of poor quality but slightly superior to the taungya paddy called "Shay Shang." The terraced land is, as a rule, cropped every year and never left fallow. The Yawyins and other inhabitants of the more elevated regions do not adopt this method of cultivation.

III. *Garden Cultivation*.—Almost every permanent Kachin household has its small patch of garden, from a few square yards to half an acre in extent, adjacent to the house. It is surrounded by a strong fence and is very frequently situated on the lower side of the house, so that the cattle manure is readily swept from the shed, through a hole in the fence, into the garden. In fact, it frequently happens that the urine and liquid part of the manure

flow from the hardened floor into the garden. This manure is but roughly spread, the greater part of it remaining near the house, but the garden soil soon becomes very rich. Cultivation is carefully carried out by hand and good garden crops are obtained.

Crops Grown.—The chief crops are as follows :—

I. *Paddy* is the chief crop grown on taungyas and on the terraces, but unless the aspect is very favourable it does not grow well at altitudes over 5,000 feet. The cultivator says that it is too cold. The varieties grown are very coarse. On taungya it is dibbled in, and on terraces it is either sown broadcast or transplanted—generally the latter. The yield is small, the markets are local and the price low. The difficulties of transport prevent exportation to better markets. It is one of the chief food crops, but is also used by the Kachins for making Kachin beer ("Cha krat cherru"), which is flavoured with ragi.

II. *Maize* is grown for local consumption—largely by the Yawyins at the higher altitudes; but also by the Kachins. It is dibbled on taungya land.

III. *Buck Wheat* (called "Shari Mam") is grown on taungyas by the Yawyins in the highest regions only. The grain is very small—not more than half the size of the European variety. It is used as a food crop for making cakes, but also largely for making liquor.

IV. *Ragi* is grown by the Kachins in small quantities for flavouring their liquor ("Cha krat cherru") and *Setaria italica* is also sometimes grown for the same purpose. They are sown on taungya lands.

V. *Beans and Peas* are grown throughout these hills, but not in very large quantities. They are dibbled on taungya lands generally with some other crop, such as maize, which acts as a support for the bean plants. They are often sown alongside fences or tree stumps, which also act as supports. The market for these is also mostly local, though some of them are frequently to be brought in the Bhamo bazaar under the name of "Kachin

pé." Here again the export is prevented by the difficulties of transport. The following are a few of the chief varieties found growing here: –

(*a*) *Dolichos lablab* ("Praing lep" (Kachin).
(*b*) *Phaseolus calcaratus* ("Ning-Krung-Shapré").
(*c*) *Phaseo vulgaris* ("H' Krain-u-Shapré").
(*d*) *Faba vulgaris* ("Sán dū-Si"), very probably introduced lately.
(*e*) *Glycine hispida* ("Lazi-Shapré Tum or Nga-si").
(*f*) *Pisum sativum* ("Sán-too-si).

VI. *Cotton* is grown in the foot hills up to about 2,500 feet high. The first crop after burning a taungya is generally cotton, which is followed by paddy the next year. It is dibbled in the same way as for the other crops. The fibre is short in staple and somewhat coarse. The seed cotton before ginning sells at about 15 lbs. per rupee and any not required for local consumption appears to be carried across the frontier into China, but the total produce is at no time very large.

VII. *Poppy Cultivation* is carried out in small patches. The seed is sown broadcast, either on taungya land or on a patch of permanently cultivated ground near the village.

On taungyas it is generally an additional crop in the rotation, being sown the year after the main crop (or the second main crop as the case may be), has been taken off. It grows well, but as the export of opium is prohibited, sufficient for home consumption only is grown.

VIII. *Tobacco* is cultivated on the light soils of some of the valleys, especially the Lwejé valley, where it is said to grow luxuriantly on the red soils without manure. It is sown and planted out on drills in the ordinary way.

IX. *Mustard, Yams, Sweet Potatoes,* and a variety of cucurbitaceous fruits are also grown on taungyas—usually mixed with the main crop—and at low elevations chillies are sometimes cultivated as a separate crop.

X. *Potatoes* grow well as a garden crop, and fruit trees, especially peaches, are to be found around most villages the

result of their distribution by the Assistant Superintendent. They, however, receive scant attention and the produce is, as a rule, very poor.

XI. *Wheat and Barley* are newly introduced crops, which have been sown under the direction of the Assistant Superintendent—in school gardens or by a few selected cultivators, in several of the chief villages. With wheat, and in one place with barley, considerable success has been attained.

Oats were also tried in the same way, but with very indifferent success.

The Implements used are of the simplest kind and differ only very slightly from those used in Burma proper. On the lower levels, the terraces and the gentler slopes, either the single-buffalo plough or the double-buffalo plough may be used; but in many places all the cultivation is carried out by hand with the aid of a kind of hoe or mamootie. As in the case of most other hill tribes, every Kachin carries his "dah" or large, heavy-bladed knife in a kind of sheath slung over the shoulder. The blade is usually about 18 inches long and broader and heavier at the end than near the handle. It is ever ready to be used for cutting, digging or any other kind of work to which it can be applied.

Cattle, etc.—Buffaloes are largely used in the valleys for cultivation, and command a high price around the chief paddy-producing tracts, as for example, near Lwejé and in the Manbong valley, which is worked almost entirely by the Chinese, though part of it only is Chinese territory. In these valleys cultivation is very carefully carried out, the land being turned up in large lumps in order to induce aëration a long time before it is required for planting. The value of this operation appears to be fully recognized by the cultivators.

Buffaloes are also made use of in certain "Nat" ceremonies. Bullocks are sometimes used for cultivation, but are very largely used as pack animals. Though slower than mules, asses or ponies, they are cheaper and serve the purpose very well on the steep hill paths. As the Kachins do not drink milk, cattle are

not kept for milk production, though breeding and rearing are carried out in most places.

Pigs are reared in all places—sometimes very largely. They are allowed to run wild around the villages, feeding on wild plants, roots and offal, but they are also fed on a kind of paddy meal (simply paddy ground-up without husking), mixed with a large quantity of water.

Manuring is very little practised, except as above described, on the garden lands attached to the houses. In some of the larger villages, however, the droppings of pigs and cattle are said to be collected and applied to the land.

Transport of Produce is one of the chief difficulties. Owing to the absence of roads—except narrow paths cut along the hill-sides, all goods, produce, etc., have to be carried on pack animals. Asses, mules, ponies and bullocks are made use of for this purpose. Consequently only the least bulky and most valuable produce can be profitably transported to Bhamo or other marketing centre.

THE CONSTRUCTION OF COW-HOUSES.*

By JOHN SPEIR, Kt St.O

THE requirements of modern life demand a degree of purity in our food supplies little dreamt of in previous generations. Milk is no exception to the general rule, and in order to obtain pure milk it must be produced by healthy cows in healthy surroundings.

In the construction of houses for the accommodation of cows intended to produce milk, either for consumption as it comes from the cow, or to be made into cheese or butter, the main requirements to be kept in view are the following :—

(1) The milk produced should run little risk of being contaminated either by dirt or disease.

(2) The animals should enjoy the best of health, and be free from risk of infection of any kind.

(3) The design of the buildings should be such that the labour of feeding and cleaning the cows should be reduced to the minimum, while the comfort of the animals should be the greatest which it is possible to give.

(4) The outlay should be such as will add as little as possible to the cost of production of the milk.

While it is comparatively easy, where the requisite skill is available, to provide new buildings which will meet all the above requirements at even a very moderate cost, it is much more difficult to alter an existing building so that it can be made as suitable for the purpose as a new one. That should not, however, deter owners and occupiers from making alterations on the lines suggested, as under suitable guidance even the most unsatisfactory buildings could often be much improved at moderate cost.

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In designing a cow-house, the principal details which should receive consideration are the following:—

Site, including aspect and arrangement with regard to other buildings.

General construction of the building, including the walls, roof, floor, drainage, and water-supply.

Internal Design, including arrangement of stalls, stall divisions, bindings, feeding troughs, manure and urine channels, passages, etc.

Air-Space, including floor space.

Ventilation, including the various methods by which this is attained; and *Lighting*.

The Site.—Where there is the opportunity of selection, the site should be moderately high and dry, convenient for the supply of fodder and roots, the preparation and storage of feeding stuffs, the removal of the manure and urine, and should give easy and ample access to the nearest pasture without interference with other stock, and without affording the cattle an opportunity to stray into other parts of the farm buildings, etc. In the designing of a completely new set of farm buildings these can usually be all provided without any great difficulty. It is when a new cow-house is being added to existing buildings, and more especially when no part of these has previously been utilised for dairy purposes, that the greatest difficulties occur. In such circumstances, it is seldom possible to get all the details worked out as completely as can be done where everything is new, but with care and skill there should be no real difficulty in effecting considerable improvement on the average building of the present day.

While shelter from heavy winds is desirable, no cow-house should have any buildings, such as hay or straw sheds, or buildings occupied by other kinds of stock, erected against the side walls. If the building is one such as an open fronted shelter for implements, little objection can be urged against it, but anything which would interfere with the proper ventilation of the cow-house should be placed somewhere else. Land is not so very costly round the

average farm that there is any excuse for crowding buildings together, as is not infrequently the case.

Walls.—The walls may be of any material which is plentiful and cheap in the district, and with suitable precautions equally good buildings may be erected of stone, brick, concrete, wood, or wood and iron. If of stone, or brick, all outside walls should be neatly pointed, and inside ones plastered, or faced with bricks, either enamelled on the one side, or hard pressed. Where plastering is adopted, cement should be used for a height of six feet from the floor. Above that the surface should be smooth, and of such a nature that it can be either washed or lime washed. If the building is to be of wood, or wood and iron, all uprights and sills should be of creosoted timber. The extra expense will not be great, while the life of the building will at least be doubled.

Roof.—While any kind of roofing material may be adopted, with more or less advantage in particular districts, a wooden roof covered with slates or tiles should be given the preference. No matter what is the material used or what is the design of the building, in every case in this country it should be open to the ridge. Other countries with more severe climates than ours may tolerate lofts and barns above, but here nothing of the kind should be permitted. The extra cost of planing the inside surface of the roof is very trifling, and from various points of view the planing is of considerable advantage.

Floor.—The first point which should be considered in connection with the floor is its level compared with the existing roadway, or completed surface round the building. In the majority of cases but more particularly on level land, or where there is a difficulty in getting sufficient fall for the drains, the floors are laid at too low a level. This is a serious mistake, which there are few opportunities of correcting, and one which is very common in old buildings. The consequence is that the floor and stalls are often damp, and the roadway outside is invariably covered with mud and slush. In not a few instances the roadway outside is difficult to improve, as it cannot be raised, owing to the risk of running the surface water into the building, instead of away from it. These difficulties

should, therefore, be guarded against by fixing the floor at a comparatively high level rather than a low one.

The main flooring materials should be either cement concrete, or blue bricks. Both have some faults, each in a direction different from the other. A perfect material for cow-house floors has yet to be introduced, but with all its faults, good cement concrete, properly laid and finished, is probably the best for general purposes, where clean sharp sand and gravel are available. If suitable sand is not easily obtained, and hard blue bricks can be had at a moderate cost, they may be used in preference to cement concrete. In putting down the floor, either for cement concrete or bricks, the bottom should be laid with stones 6 to 8 inches deep. These should be sufficiently large to fill up the whole depth in one layer, each stone being separately placed in position by hand. A layer of ordinary concrete 3 to 4 inches thick should be placed on the top and well beaten down among the bottoming by hand beaters. Before the concrete has set, it should be covered with one inch or so of two parts of crushed granite and one part of cement. Instead of being floated or smoothed on the surface this should be left rough, as when smooth it is always slippery, unless when well washed. It is generally recommended that the passages and hind part of the stalls should be V grooved, but this has little effect in preventing slipping where the passages are not kept thoroughly clean, while the wheels of coolers, or other carriages used in the conveyance of food to the stock invariably break the surface at the grooves. Properly finished concrete is scarcely ever slippery if clean, but may be more or less so if dirty. It is fully as cheap as any other flooring material laid equally substantially, is less absorbent than most, and probably more durable than any other. Where blue brick is used for the passages and stalls cement might with advantage be put in the bottom of the manure channel, as there are no junctions as with bricks to hold urine and manure, and the uniform gradient necessary for this part is more easily maintained with cement than with bricks.

Drainage.—There is general agreement among those who know this subject best that there should be no covered drains

inside the cow-house, or if there are, they should be reduced to the shortest length possible. With buildings having two rows of stalls, particularly those of the largest size, it is not always convenient to have open drains, as occasionally the fall is to the centre, and in that case a covered drain has often to be made from the manure channel to the outside. In such circumstances no one need hesitate in putting in a covered drain, rather than have an open one in an awkward position, where the risks from the open drain may be much greater than from the closed one. In such circumstances no pipe should be put in less than six inches in diameter, and pipes eight or nine inches are to be preferred. The pipes should be given a steep gradient, say, one inch or more for each three feet length of pipe. There should be no bends in the line of piping, which outside the building should end in a small cess-pool. The entrance at the manure gutter should be protected by a grating, and any good pattern of sludge collector.

The drainage outside the cow-house will, in great part, depend on how the urine is to be disposed of. Urine drains are always difficult to keep clear, and in consequence they should be given a good fall and kept as short as possible. If there are any bends, pipes with loose covers should be inserted at each, and if the length is great or fall, little pipes with loose covers should be inserted at frequent intervals.

A good method for utilising the urine is to have a tank close to the dungstead into which all leakage from it should run, and into which the drain from the cow-house should discharge. A urine tank in such a position permits of the contents being distributed over the top of the manure heap, when there is not a suitable piece of land to apply it to. One of the most economical methods of utilising urine is to spread it on permanent hay meadows. If so utilised it may be carted on, but better results will be obtained and less labour will be required if the urine can be diluted with water, and spread over the land by small irrigation channels.

Water Supply.—The best supply is by gravitation from some perennial spring at a higher level, after which come supplies from

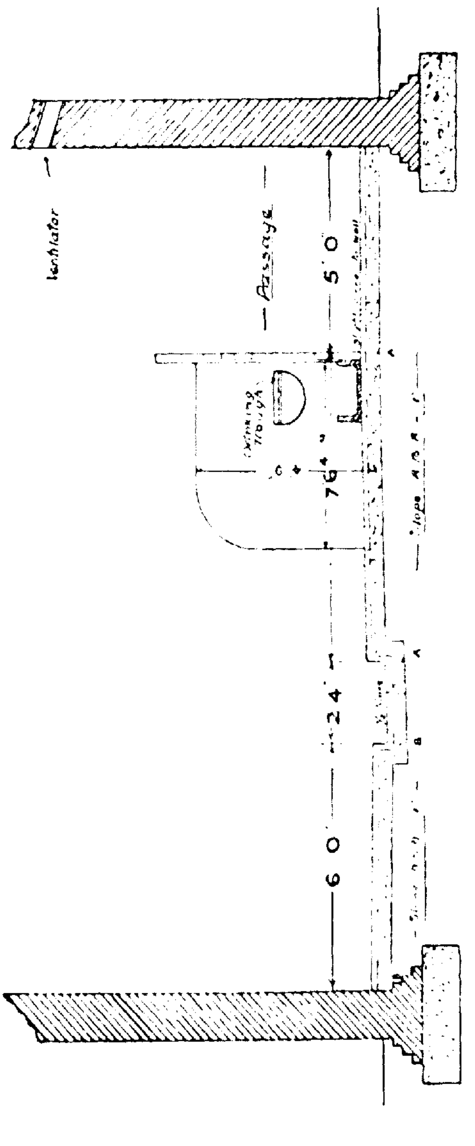


FIG. 1. SECTION OF COW-HOUSE: ONE ROW OF STALLS AND FEEDING PASSAGE. (SCALE ½ IN. TO 1 FT.)

streams, lakes or ponds. In many cases springs and rivers at a lower level can be utilised, and part of their contents conveyed to the farm by a ram or windmill. These sources are only available for a limited area of the country, and in the majority of cases the average farm has to depend on well water. In such circumstances a sufficient supply should be provided in storage tanks at such a height as will permit of it being distributed to the cow-house and milk-cooler.

Internal Designs.—The utility of every building will in great part depend far more on the design adopted than on the materials used in the construction of it. Expensive materials may be used in the construction of a cow-house, yet owing to the imperfection of the design very unsatisfactory results may be obtained. On the other hand, very plain materials, if worked up into a good design, may give very satisfactory results. While excellence in materials should always be aimed at, much more will depend on the design than the materials.

The method of stalling the animals adopted in Fig. 1 is one of the oldest, and at the same time one of the most approved, more particularly where existing farm buildings are being utilised for cow-houses. Many ordinary farm buildings are from 15 to 20 feet wide, and where it is desired to transform them into a cow-house, this can usually be accomplished at a very moderate expense. Where, however, a new building is being erected it will be more economical to adopt design No. 2, where the same principle is followed as in No. 1, except that two rows of cows are provided for, instead of one.

This arrangement has a great deal to recommend it from various points of view, and although the initial cost is fairly high the advantages obtained warrant the extra expense. In building a new cow-house, unless for a very small number of cows, the two-row design will in nearly every case be adopted, as the cost per cow is somewhat less than in the single one. The extra cost for a cow-house on this plan is not so great as would appear at first sight. It is desirable to provide a certain cubic or floor space for each animal, and the cost of the extra passage is saved in the

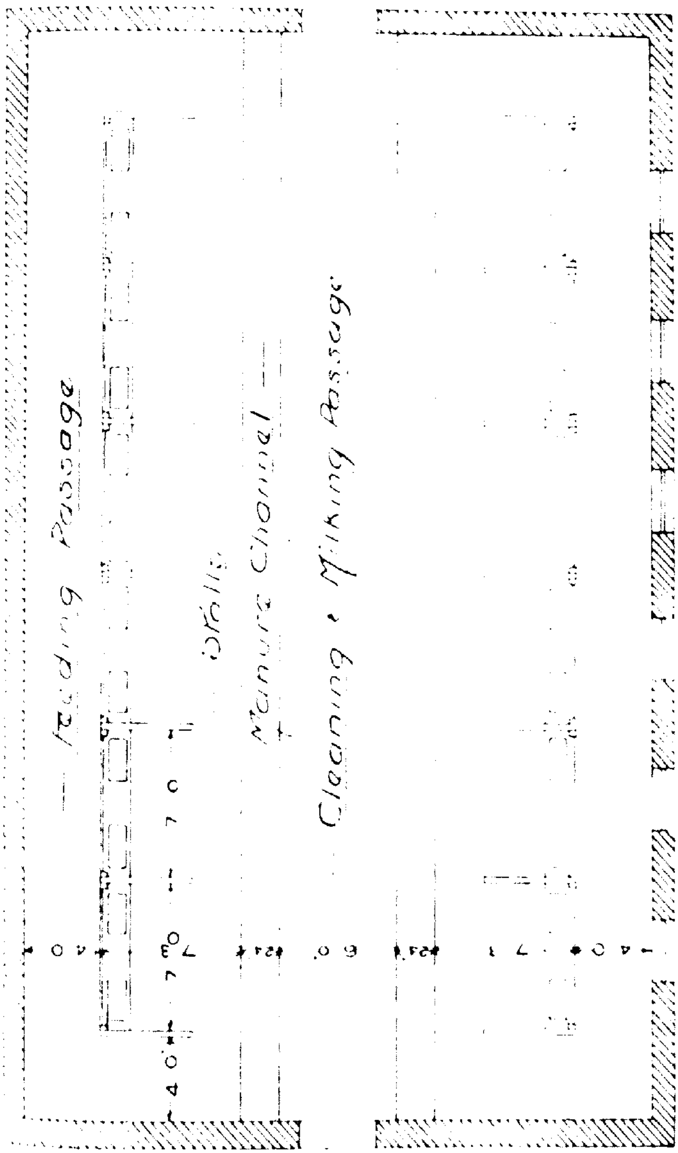
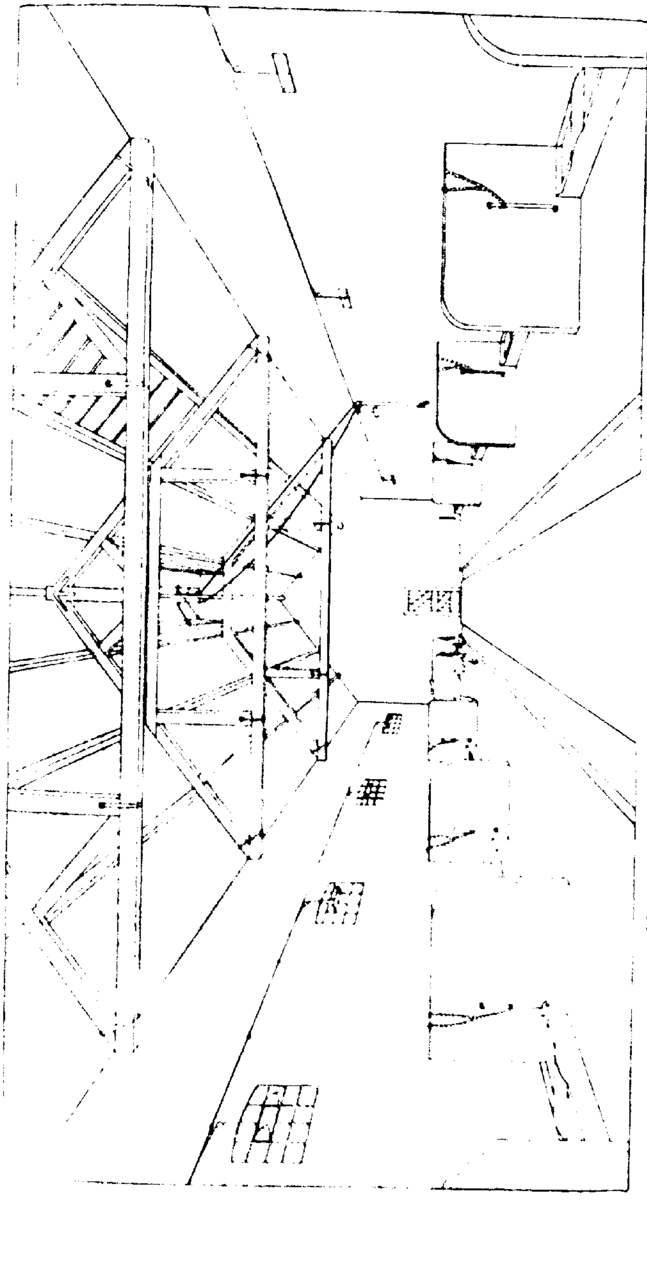


FIG. 3. GROUND PLAN OF COW HOUSE. TWO ROWS OF STALLS AND FEEDING PASSAGE. (SCALE [illegible] IN. TO 1 FT.)

walls, which do not require to be made the same height as in a building without any passage at the heads of the cattle.

In many of the dairying districts a passage between the heads of the cows and the wall is considered unnecessary and undesirable, because (1) any saving in labour that is effected by feeding the cows from a passage at their heads compared with one from behind is only trifling, and is more than discounted by the extra labour necessary to keep that passage clean; and (2) when animals have been lying for a time they very often pass some excrement as soon as they rise. Where there is a feeding passage at their heads the cows usually rise when feeding begins, and in their anxiety to be fed they generally press toward the passage, and if the fittings permit of it, they often thrust their heads over the division. Any excrement dropped at this time, as is often the case, falls on the floor of the stall, instead of in the manure channel. If this is not cleared away soon after, the cow may lie down on it later on, and soil not only her hindquarters, but also her udder and teats. With a bullock intended to be slaughtered this would be thought little of, as it is not in any way likely to effect the quality of the flesh of the carcase. It is, however, quite the reverse with a cow giving milk, as clean milk can never be obtained from a dirty cow, much less from one with her udder or teats soiled with her own excrement. Milk produced under such conditions is disgusting. Where the division in front of the cows, however, is made high enough to prevent them putting their heads over the top of it, there is no greater liability of the stall being soiled than if the animals were tied up with their heads to the wall.

Cleanliness of the udder and teats or the hands of the milker is a comparative term, and will be variously interpreted by different people. At the International Congress on Dairying at Buda-Pest in 1909 Dr. Paul Schuppli gave the following definition: "The udder (and particularly the teats) should be so clean that no one would shrink from touching them with lips or tongue." This is one of the best definitions of cleanliness of the udder and teats that has yet been given, and the more it is considered, the greater will be found the necessity for its general application.



INTERIOR OF COW-HOUSE.

Fig. 8.

In addition, milk once polluted can never be made clean, as sieving and pasteurising only cover up the pollution by removing what is objectionable to the sight, but, after all, the pollution remains very much the same as before.

In many parts of the country the most common type of cow-house is that represented in Fig. 3, in which the cows are stalled with their heads to one of the outside walls. In these cases the one central passage serves the purpose of conveying the food to the cows, removing the manure, and taking away the milk. Like plans No. 1 and No. 2, this one may be either single or double, the latter being the cheapest building that can be erected. It does not, however, give the same opportunity for supplying the stock with fresh unpolluted air that designs No. 1 and No. 2 do, as the air at the head of the stalls is always more polluted than in any other part of the building, whereas it is there that pure air is of most advantage.

There is a type of cow-house which is very common in many districts of Britain but which is objectionable in various respects. In it all the stock are fed from one central passage, while the manure and the milk are removed by the two at the sides. In this case the cows' heads are as far removed from the fresh air inlets as they possibly can be, while the animals breathe into each other's faces from opposite sides of the passage. In a building of this class, where not exceptionally well ventilated, the general health of the stock is likely to be low, and one infected animal in the lot may cause a great amount of damage. It is also defective, in that the passages from which the milking is carried on are usually too narrow to secure milk standing on them from risk of pollution, as where the passages are under 5 ft. or 6 ft. wide, the walls behind the cows are often spattered with dung.

Passages.—The majority of cow-houses usually have the passages much too narrow. A feeding passage cannot be worked in with comfort if the breadth is less than 4 feet, and it will be all the better if made slightly more. Milking passages, no matter whether in single or double buildings, should not be less than 6 feet wide for single cow-houses and 6 to 7 feet for double ones. This width is not necessary, either for feeding or cleaning, but to

most farms, particularly the larger ones, nothing less should be allowed for a milking passage. It is only on the very smallest of farms that each milker carries the milk direct from the cow to the dairy or cooler. The common practice is to have special cans for

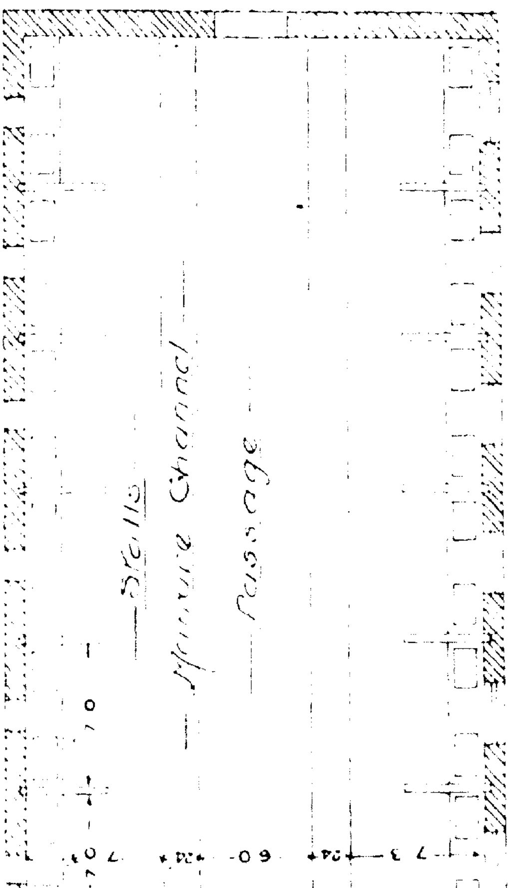


Fig. 3.—Ground Plan of Cow-house shown in Fig. 2: Two Rows of Stalls, without Feeding Passage. Scale, 1 in. to [illegible] ft.

-rving the milk, and during the operation of milking these are -- in the passage or walk, and as each cow is finished, the milk is -tied into these cans. When full, they are carried to the dairy

or refrigerator and emptied, after which they are returned to their place in the passage. With a double cow-house where the passage is less than 6 feet wide there is always a risk, while they remain there, of a cow near at hand passing either urine or dung, and part of these not only getting splashed on the can, but also into it. The narrower the milking passages are, the greater is the risk of this source of pollution, which, although always present, is more pronounced during the season when pasture is young and succulent. Single cow-houses with 24-inch manure channels and 5-ft. passages behind the cows become spattered with dung even during the winter months, so that it is quite evident that cans of milk standing in the passage run more risk of pollution than most people care to admit.

Stalls.—The stalls of cow-houses only require a very trifling incline from the trough to the manure channel. Each spring when the cows go out to the pasture the stalls should be thoroughly scraped, and all filth removed. This necessitates soaking the stall with water, and, when the dirt has been removed, thoroughly washing it out, and unless the stall is given a fall of from one to two inches, it is difficult to get the floor dried.

Each stall should be proportionate in length to the class of cow that is expected to occupy it. For the smallest size of cows, such as Jerseys, Kerrys, and young Ayrshires, the stall measured from the wall or division between the cows and the passage to the manure channel should be from 6 ft. 9 in. to 7 ft long, inclusive of the breadth of the trough. For Ayrshires, a stall of 7 ft. to 7 ft 3 ins. is quite sufficient, while Shorthorns require from 7 ft. 3 ins. to 7 ft. 6 ins., and exceptionally large cows 3 ins. more. If the stalls are too short for the cows, they will stand in the manure channel, and sooner or later the feet become soft and diseased. If the stalls are too long for the stock, they drop their dung on the floor, and later on when they lie down they are almost sure to soil their hindquarters or udder with it. Where this state of matters exists the extra labour necessary to keep the stalls and cows reasonably clean is very great, and out of all proportion to what is necessary to reduce the stall to the proper length

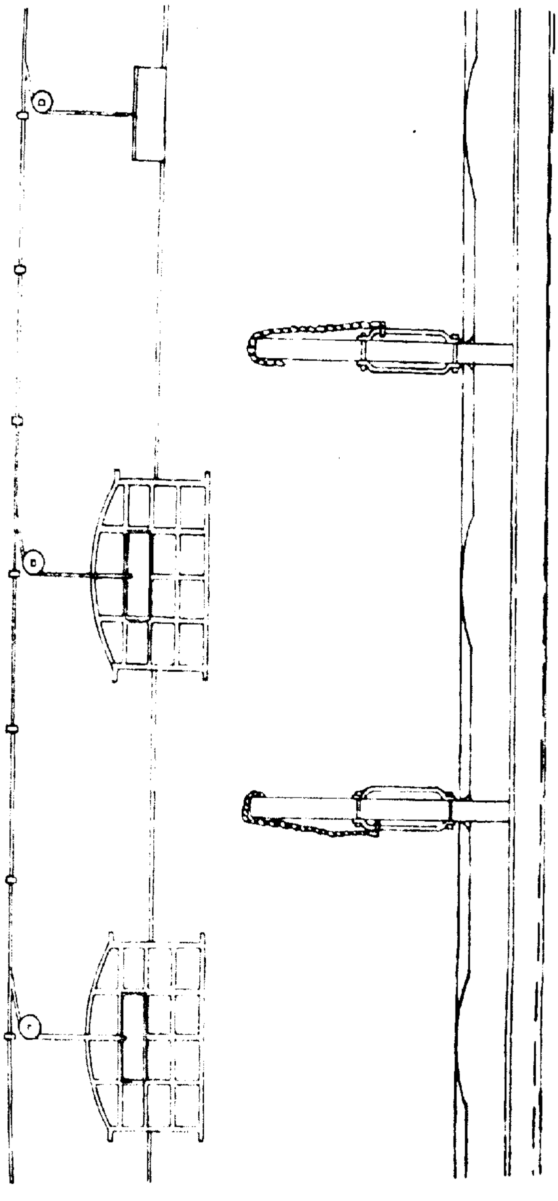


FIG. 38.—SECTION OF STALLS OF COW HOUSE SHOWN IN FIG. 3. DOTTED LINE SHOWS FALL IN MANURE CHANNEL. (1 IN. IN 7 FT.)

For the smaller size of cows, each double stall should be from 6 ft. to 6½ ft. in width, and for the larger ones, from 6½ ft. to 7½ ft. wide. If the stalls are too narrow, the cows tread on each other's legs, udder, and teats, and in the latter two cases injury to these almost invariably means loss of a quarter. If the stalls are too wide, the cows turn round in them, and drop urine or excrement in the trough, or on the floor of the stall. While the back part of the stall may be of cement concrete, blue brick or stone, the front part should be of brick or hard asphalt only.

Stall Divisions.—The stall divisions may be of cement, concrete, stone, wood, or iron, or in the event of stanchions being used, they may be done without altogether. Coloured or uncoloured cement 3 ins. thick is, however, one of the strongest, neatest, and most serviceable divisions yet introduced, as it is almost everlasting, and saves painting, periodic washing with water or lime washing being all that is required to keep it clean and bright. The stall divisions should not be less than 4½ ft. long, and 4 ft. to 4 ft. 3 ins. high. With the swinging stanchions used in Canada and the States the cows can be much more quickly tied up than with our method of chains and hooks, while the attendant runs less risk of being hurt by the horns of the animals while so engaged.

Troughs.—Each cow should have a separate feeding trough of thoroughly glazed fireclay, as separate troughs for each animal are much to be preferred to continuous ones. It is a mistake to put in very large troughs, those 20 by 16 by 8 ins. being quite large enough for most purposes. Each double stall should have the space between the two troughs filled up with brick. This keeps each trough sufficiently far away from the neighbouring animal that it cannot steal any food. All the corners along the back and ends of the troughs should be filled up with cement to as long a slope as possible, so as to prevent unconsumed food, bits of straw, and filth of any kind from lodging there, and, when putrefaction begins, setting up bad smells.

Where it is desired to provide facilities for supplying the stock with water when in the house, one of the best of many methods is to have small circular troughs 9 ins. or so in diameter, set in

recess cut out of the stall division close to the wall or division, and 1 ft. or so above the trough. These troughs should have a lid which is hinged at the back and projects over the edge ½ in. or so, and it should be so arranged that it cannot be lifted up to a perpendicular position. All stock seem to learn to lift the lid with their nose in a few days, and as soon as they have satisfied their thirst, the lid falls and keeps out dust, straw, etc. The level of the water in the troughs may be regulated either by a ball cock, or, if water be plentiful, it may pass off by an overflow at any or all of the troughs. If there is a feeding passage, the overflow may pass away by an open shallow gutter in the floor along the side nearest the troughs.

Manure Channel.—Probably no part of the average cow-house is constructed in so faulty a manner as the manure channel. In no case should it be less than 24 ins. wide, and for large-sized cows it may with advantage be increased to 27 or 28 ins. It should not be less, and need not be greater than 6 ins. deep at the cow's heels, and at the side next the passage 4 ins. will be quite enough. A fall lengthwise in the floor of the channel of ½ in. for each cow is quite sufficient. These in themselves are trifling details, but they are items of immense importance in connection with the cleanliness of the animals, and indirectly with the purity of the milk. The reason for making the manure channel as suggested above is that when the cattle have been in the house for a few hours, the manure which they make is so great that if the channel is any narrower than suggested, it becomes blocked with manure from side to side. In the interval more or less urine is constantly being passed by all the animals and instead of getting an outlet to the cistern, it remains dammed for the time being between each heap of manure. Under these conditions every time a cow lies down there is a liability of her tail dropping into the pool of urine, which later on she switches over her own body and that of her neighbours. This mixture of urine and thin dung is soon dried by the heat of the bodies of the animals, and during the act of milking part of it becomes detached in the form of dust, and drops into the milk. Cows so stalled can only be kept reasonably clean by

the expenditure of an excessive amount of labour on the part of the attendant, and no matter what amount of care is exercised during the process of milking, the milk itself is sure to suffer.

Before a cow-house can be considered efficient in regard to the cleanliness of the animals, or the purity of the milk, it must be provided with a manure channel having a minimum width of 24 ins., and constructed as suggested. People who have not had experience of a wide manure channel fancy that the cows will have difficulty in stepping across it. Such is not the case, as they seldom make any attempt to step across it. They simply seem to ignore it, as owing to its shallowness they step into it, as if it were not there. Even although every known precaution is taken, extraneous matter will at times enter the milk, but if the manure channel is badly designed, or if the work is indifferently executed, it will be found almost impossible to produce milk even approximately pure.

Floor Space.—While some of the details in connection with the construction of cow-houses have in the past received more consideration than their importance warranted, the question of floor space is undoubtedly one to which somewhat more attention might reasonably have been devoted. It is closely associated with the feeding and milking of the cows; with the removal of the manure; and more especially with the cleanliness of the milk. The area required by a cow for her comfort is very much regulated by her size, but all require about a similar number of square feet for proper attention. With passages of the width suggested for the different designs of cow-houses, a floor space of from 40 to 50 square feet will be provided per cow, and for the large class of animals it may with advantage go higher for some of the principal designs. These areas may by some be considered excessive, but it should be remembered that every increase in the floor space also adds to the cubic space, and both materially assist in keeping the air in the building in a reasonable state of purity.

Cubic Space.—By sanitary officers cubic space has hitherto been the standard by which they gauged the efficiency or non-efficiency of a cow-house. Provided that this detail corresponded with

their ideal, little attention was devoted to the other matters already referred to, which have a greater influence on the purity of the milk or health of the stock than does cubic space. It is a very necessary detail of a healthy cow-house, but it has hitherto been given an importance far greater than it deserved. This has been brought about under the mistaken idea that in a building with a large cubic space the air remained approximately pure much longer than where the cubic space was smaller. Where buildings such as churches, halls, and theatres, etc., are occupied for a limited time compared with the interval during which they are empty, the inference is reasonably sound, but when applied to the case of a cow-house in which the animals are constantly stalled for half the year, it breaks down entirely. In the one case the building is flushed with fresh air in the intervals between its occupation, while in the other it is seldom that such an opportunity occurs. The consequence is, that the air of a cow-house, no matter how large its cubic space, reaches a high degree of impurity in an hour or two after it becomes occupied, unless provision is made for removing the polluted air, and replacing it by that which is pure.

This was strikingly brought out in the experiments of the Highland and Agricultural Society during the winter of 1908 and 1909, in which the air of several cow-houses of medium and large cubic space, but with limited provision for change of air, was compared with others similarly placed, where it was liberal. In those which were freely ventilated, the cubic space per cow varied from 520 to 1,268 cubic ft. In the smaller building, where fully ventilated, the average carbon dioxide in the air, on an average of fortnightly tests by chemical analysis, was 10·6—the minimum being 6·5 and maximum 15·9—per 10,000, the average temperature being slightly under 49° F. In almost similar buildings, with the ventilation restricted, so as to keep the temperature about 60° F., the carbon dioxide in the air of samples taken at the same time as the other was 29·05 per 10,000, and in some instances was as high as 60, 70, and even 88 per 10,000 volumes. On the average of three tests at one of the farms, the air of the freely ventilated building, with a cubic capacity of 1,130 cubic ft. per

cow, contained 9·4 per 10,000, while an adjoining building, with 705 cubic ft. per cow, but with little ventilation, contained 29·03 per 10,000. On two of these farms, at about the same elevation, in the same district, and with much the same exposure, the carbon dioxide in the air of the smaller of the freely ventilated buildings was 10·6, while the very large one was 9·4 per 10,000, a difference of only 1·2 of carbon dioxide per 10,000, although the one building is fully double the other in capacity per cow. In the buildings with restricted ventilation, the amount of carbon dioxide was identical in both cases, yet the one building had 480 cubic ft. per cow, while the other had 705 cubic ft. In both cases the samples were taken between two and three hours after the buildings were closed for the night.

In another case, with buildings at a high altitude and exposed situation, but having a large cubic capacity, the dangers and difficulties of attempting to maintain a high temperature in the cow-house are very evident. The ventilated building with a cubic capacity of 1,268 ft. per cow, and an average temperature of 49° F., had on an average of four tests 19·7 of carbon dioxide per 10,000 volumes of air. In the other half of the same building, where the cubic space was 918 cubic ft per cow, and average temperature 57·5° F., the carbon dioxide in the air on an average of four tests was 60 per 10,000 volumes of air. At the other farms where this experiment was carried out almost identical results were obtained. The average for twenty-one tests made on five farms in mid-winter gives 12·8 volumes of carbon dioxide per 10,000 of air for the buildings more or less freely ventilated, and having an average temperature of 49·8 F., while a similar number of trials on the same evenings in similar adjoining buildings, but with restricted ventilation and an average winter temperature of 59·4 F., the carbon dioxide present was 34·7 volumes per 10,000 of air. The results of this experiment emphatically show that there is no gain in purity of the air, corresponding with the cost, in buildings of very large cubic capacity per cow compared with those of more moderate size. They also prove that if any cow-house, no matter what its cubic space per cow, is kept at a temperature of 60° F. or

more, its air will contain about three times as much carbon dioxide than if the building had been freely ventilated and kept at under 50° F. While the production of milk may be as great in the one case as in the other, the health of the animals in the freely ventilated building will remain good, while the constitution of the others will gradually become enfeebled.

If the other details in connection with the construction of the building are attended to, it will be found that fairly good results may be obtained if 420 to 450 cubic ft. are allowed for the smaller breeds of cows, such as Jerseys and Kerrys, and young Ayrshires. Breeds of, say, the size of the Ayrshire should be allowed a minimum of 500 cubic ft., and the larger breeds, such as Shorthorns, say, 600 cubic ft. While there will be some advantage in increasing these minima by 20 to 30 per cent., little return will be obtained for the money expended in making them any larger.

Ventilation. Closely associated with cubic space, but in reality quite a separate subject, is that of ventilation. While a certain floor and cubic space must be provided before the cows can be conveniently and economically attended to, the health of the animals and purity of the milk will in great part depend on the means provided for ventilating the building. Even the thoroughness of the ventilation is much more a matter of providing in the walls ample openings of any kind as inlets for the air, and the same in the roof for its exit, rather than any special system of ventilation. No class of building is so easily ventilated as that which is open to the ridge, and in none may the system which is adopted be so simple and inexpensive. The great requisite is to provide for each animal plenty of inlet area, which should not be less than 40 sq. ins. per cow, irrespective of doors or windows, which should be reserved for exceptional weather, and if the situation is at all sheltered, more should be provided. It does not follow that all available ventilation should be always utilised, but sufficient openings should exist to keep the air fresh—say, 8 to 12 of carbon dioxide per 10,000 volumes when the stock are in, and the air is calm. These openings should be provided with some arrangement by which the inlet of air can be easily regulated to suit the conditions of weather. For instance,

if the wind is strong the volume of air which will pass through any opening will be many times greater than when it is calm, and it is to provide for such occasions that some system of regulation is necessary. The old system of putting straw in the openings in stormy weather cannot be recommended, as when a change of weather occurs the straw is almost invariably in when it should be out, and out when it might be in. The outlet ventilating openings should not be less in area than the inlets, and may with advantage be 100 per cent. greater. Like the inlets, the outlets should be provided with some system of partially closing them when it is desired to do so.

The simplest and one of the most serviceable of inlet openings is a flat one 24 ins. by 4 ins., or 18 ins. by 6 ins., in the wall opposite each double stall. This opening should be between 5 and 6 ft. from the floor if the animals are stalled with their heads to the wall, but if a passage intervenes, it may be somewhat lower, as in this case the current of cold air becomes modified and diffused in its course across the passage, and before it reaches the cows. If a board 9 to 12 ins. broad and 24 ins. long is placed flat along the bottom of this opening, and the edge next the outside of the wall is hinged in any convenient manner, an arrangement can be easily fitted up by which each or all of these boards can be raised, so as to reduce wholly or partially the incoming current of air. The valve may not only be used for reducing the volume of air entering the building, but also for diverting the current in an upward direction, so that it may pass over the bodies of the cows. There are numerous devices for attaining the same end, all of which serve the purpose fairly well.

The simplest system of roof ventilator is a box extending over two or three of the couples, and rising 18 or 24 ins. above the ridge, and having louvre boards on the sides. The main point in these is to have them large enough and in sufficient number. Another method is to have the boarding of the roof, for a foot or so on each side of the ridge, hinged on the under edge, so that it opens up and leaves an outlet 12 ins. or so wide the whole length of the building. Arrangements have to be made for raising and lowering the flaps from the floor.

Light.—Everybody admits the advantages, so far as health is concerned, of an out-door life, but just how much is due to fresh air and how much to the influence of sunlight it is very difficult to say. Sunlight is, however, known to be one of the most powerful, as it is one of the cheapest, germicides we possess; it therefore should be admitted freely into all buildings occupied by stock. It is a matter of indifference whether it comes from the walls or roof, provided it is ample and does not fall directly on the eyes of the animals. The minimum allowance should not be less than 2 or 3 sq. ft. per cow, and it will be an advantage to have even more than that. Of all the details connected with cow-houses, few of them have received so little consideration as that of lighting. This omission has been in part due to the erroneous belief that stock fatten quicker in the dark than in the light; but, in any case, nothing will contribute so much to cleanliness in the cow-house as plenty of light. It costs little, and its value there is great, if it were for nothing else but to afford an opportunity of seeing the dirt.

Manure and Food Conveyors.—No cow-house can be considered complete which is not provided with an overhead railway for the purpose of removing the manure, and bringing in food and litter. In Canada and the United States these are found everywhere, their cost is trifling, and the labour they save is great. The manure bucket is self-emptying, holds between three and four barrow loads, and is more easily pushed than an ordinary barrow, and if the rail can be laid with a slight fall to the dungstead, the load may run out and empty itself. Separate buckets are used for the carriage of the manure and the food.

NOTES.

THE ASSISTANCE OF THE COURT OF WARDS IN AGRICULTURAL IMPROVEMENT. It is well to define at the outset the limits of the activity of the Court of Wards.

(1) Apart from statutory limitations which exist in some provinces, the Court is morally in the position of a trustee, that is to say, it cannot spend money freely in the way a landholder can: it is justified in making improvements which will either increase the rent-roll, or ensure larger collections in unfavourable seasons, or contribute to the general welfare of the tenants, but it is not justified in spending money on costly experiments.

(2) The tenure of the Court is uncertain, and there is in ordinary circumstances little hope of continuity of management after its term expires. The best chance of carrying out a long term programme exists where a solvent estate comes under the Court for a minority of 15 to 20 years; but even in that case the minor may die and be succeeded by an adult Hence elaborate schemes of stock-breeding, afforestation, and the like which require prolonged maintenance before a financial profit accrues are ordinarily unsuitable to the conditions.

(3) A very large proportion of the estates under the Court are so deeply indebted that expenditure in all directions has to be cut down to the lowest limits.

It follows from these limitations that the capital expenditure on improvements is most likely to be justified when it is incurred once for all on works of definite agricultural utility such as irrigation or drainage projects. In the larger part of the United Provinces the need for more masonry-wells is more pressing than anything else, and I have usually advised that

estates with moderate resources should practically confine their capital outlay to the provision of wells so long as these are required.

There are, however, ways in which the management of the Court can aid in the improvement of agriculture without heavy initial outlay. Among those that are suited to the province may be instanced.

(1) *Introduction of new staples and renovation of seed-stocks.*—In this case the capital invested in seed can ordinarily be recovered at harvest, and the amount required in any year is not large as the introduction must be gradual. Sugar-cane, ground-nuts, and better varieties of wheat and other crops have thus been introduced in particular estates.

(2) *Maintenance of implement depots.*—Where cultivators can buy or hire such things as improved ploughs, sugar-cane mills, irrigation-pumps, well-boring tools and the like, these depots should be self-supporting almost from the start and can be opened on quite a small scale: the most essential feature is a mechanic able to keep the implements in order and execute necessary repairs. It has also been found advantageous to give away a few implements or lend them free of cost to tenants who have earned a reward in cases where it is desired to popularise a new implement.

(3) *Provision of facilities for the demonstrations of the Agricultural Department.*—These cost little on the lines on which demonstrations are worked here, since the department asks for little beyond the loan of a field here and there and the use of bullocks for tilling it. Past experience of demonstrations conducted by the subordinates of the Court has been highly unsatisfactory: hence the desirability of the conduct of the demonstrations being in the hands of the Agricultural Department in cases where the Manager himself is for any reason unable to supervise them effectively.

(4) *Provision of facilities for experiments at Government cost.*—The Court can render much assistance by providing land and other facilities for experiments which it is desired to carry on in a particular locality.

(5) *Maintenance of communication between the tenants and the Agricultural Department.*—This is not a matter of expenditure: on the one side, there is the distribution of the department's leaflets or popular bulletins so that they may come into the right hands: on the other, there is the prompt supply of information to the department in cases (*e.g.*, outbreak of insect-pests) where its help is required, and assistance in any operations which it proposes to conduct.

To secure success in operations of the nature indicated above, close co-operation is required between the management and the officers of the Agricultural Department (except where as in Madras the Court employs an agricultural expert of its own). Formerly this co-operation was secured to some extent by periodical conferences of the Managers under the Chairmanship of the Director of Agriculture: of late years the practice has been that when an important estate comes under the Court, the Director or Deputy Director confers with the Collector and the Manager, and a scheme of improvements is agreed upon. Further the portions of the Managers' annual reports dealing with agricultural improvements are reviewed by the Director in a note to the Court. The main point is to establish harmonious personal relations between the Managers and the Officers of the Agricultural Department.—(W. H. MORELAND).

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SOME MANURIAL EARTHS OF MYSORE. In Vol. IV, Part I of this Journal, Mr. Harrison, Agricultural Chemist to the Government of Madras, gave an interesting account of "Pati Mannu", which is being used by the *ryots* of the Krishna Delta as manure for paddy-fields. In certain parts of the Bangalore district in the Mysore State, a similar practice exists of using as manure of earth dug out from what are probably the sites of old and deserted villages.

Some samples were taken for analysis from the villages Chikkabanavara, Kakolu, Kadanur, Rajagatta and Andarlahalli in the Bangalore district where the earth was dug from fields close to existing villages. In almost all of them fairly large

excavations have been made, some of them over two hundred feet square and six feet deep. In the village of Tubkunte it is reported that the excavations are some acres in extent. But all the larger ones have now been abandoned by the order of the Revenue authorities as these areas are unfit for cultivation. In other places small pits are dug in the fields just before the cultivation season commences, and the earth is either sold or used by the owner himself. The price of the earth varies from four annas to eight annas a cartload.

The earth is ash coloured, as its Kanarese name "Boodhi Mannu" indicates, and is very light and porous with a free admixture of sand. The pits always contain pieces of broken pottery and also occasionally pieces of bones.

In the above-mentioned villages the earth is used as manure for *ragi*, and in one of them for sugar-cane also. It is reported that in years of good rainfall this manure gives good results, while in years of poor rainfall it is more a disadvantage than otherwise a fact which finds an explanation in the sandy and porous character of the material.

Nine samples were analysed to determine the amount of nitrogen, phosphoric acid, lime and potash. The analyses are given below :—

No. of sample.	Locality.	Nitrogen.	Phosphoric Acid.	Lime.	Potash.
554	Andurlahalli	·065	·54	2·50	·55
555	Ditto	·040	·62	2·75	·55
561	Chikkabanavara	·120	1·10	4·00	·42
560	Ditto	·052	·56	·82	·31
562	Kakolu	·230	1·60	2·73	1·02
563	Ditto	·084	1·16	3·25	1·19
566	Kodagahalli	·077	·58	2·76	·45
573	Kadanur	·057	1·00	3·00	·99
571	Rajagatta	·057	1·20	2·82	·52

The samples are all strikingly rich in both lime and phosphoric acid and some of them in the other constituents as well. Sample No 562, which shows the highest percentage of nitrogen, is the only one found to contain nitrates also. Sample No. 560 is not really a sample of "Boodhi Mannu", but a sample of

surface soil of a field a few feet below which the characteristic ash-coloured earth was dug, and out of which sample No. 561 was taken. The surface soil of the adjoining fields was somewhat similar in appearance, and this sample was analysed to see if the soil of these fields was also rich. It certainly does contain a good percentage of lime and phosphoric acid. Sample No. 574 is a sample of "Boodhi Mannu" taken from the village of Rajagatta which, according to a tradition, produces the best *ragi* in the whole province. The earth is largely used to manure *ragi* fields in the village; the soil of the fields of this village resembles manurial earth in appearance, and it is reported that almost every field contains this earth, and has been dug for the sake of the manurial earth at one time or other (A. K. YEGNA NARAYAN AIYAR).

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REPORT ON "KAHNO" WHEAT FROM SIND. This wheat is grown at present to a limited extent in Sind chiefly for domestic consumption. It was found on the Government Farm at Mirpurkhas to be an excellent yielder, hardy grower and to have good rust and "kalar" or alkali resisting properties. On enquiry, however, from various exporting firms in Karachi, it was found they would not buy as they stated its only use was as *macaroni* wheat. The Imperial Institute, London, reported as follows:

Chemical Examination.—"The wheat was examined chemically to determine the proportion of gluten present with the following results:—

	Sample as received.	Gluten in dry Wheat
Gluten per cent. ...	... 11·70	13·46
Moisture per cent. ...	... 13·10	..

"The gluten was of good quality, fairly elastic, and not too dark in colour.

"The amount of gluten in American *macaroni* wheats usually varies from 12·5 to 17·9 per cent. in the dry wheat and occasionally rises to as much as 20 per cent.

Commercial Valuation.—"Samples of the wheat were forwarded to firms for *macaroni* manufacturers in France, Italy

and Sicily for examination. The Sicilian firm stated that this Indian wheat may be considered suitable for making *macaroni*, but they pointed out that when large quantities of wheat of this quality were imported into Sicily it was found to answer the purpose better if mixed with hard *taganrog* wheats, in the proportions of one-third of the latter.

"A firm in Naples reported that this wheat was perfectly suitable for making *macaroni* and stated that they would like to receive offers of consignments. Information is given below as to the average price of *macaroni* wheat in Naples.

"A London firm doing a large trade with Italy in wheat for *macaroni* expressed the opinion that this sample of Indian wheat had been especially hand-picked for exhibition purposes, and they were of opinion that nothing like it could be delivered for consumption. This firm also stated that if the enquiry was connected with a proposal to export the wheat they would be glad to receive offers.

"A French manufacturer of *macaroni* who was consulted, drew attention to the existence of great prejudice against Indian wheats on the part of *macaroni* manufacturers in France and Italy on account of the prevalence of weevils in the grain. He stated that as a rule manufacturers in buying wheat ask for a guarantee that Indian grain is absent. Recently, however, offers of Indian hard wheat had been received at Marseilles, owing probably to the present storage of hard wheats.

"With reference to the prices of *macaroni* wheat in Europe it is stated that the only hard wheat at present imported into Naples for the manufacture of *macaroni* in Russian hard wheat, which is sold at the average price of 22·75 lire per 100 kilos (equivalent to 9*s*. 3*d*. per cwt.) c.i.f. in bulk, cash against documents, one per cent. discount. Of Indian hard wheat, only small lots have been sold of Hard Red 70 per cent. at 22⅜ lire per 100 kilos (9*s*. 1½*d*. per cwt.) c.i.f. in bags, gross for net cash against documents, one per cent. discount. There is also a commission of one per cent. from seller to agent to which the above prices are

subject. The great difficulty in the importation of Indian wheat is the time of shipment.

"Shipments should be made before the 15th May by direct steamers of the Navigazione Generale Italiana, as otherwise the wheat would come in when the new crop was ready." —(G. S. HENDERSON).

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AKUND COTTON.—In Part III of the 'Indian Industrial Guide' published in 1907 by Babu D. R. Ghose, B.A., of the Provincial Civil Service of Eastern Bengal and Assam, an account is given of jungle products likely to prove profitable articles of trade to men of little or no capital. Amongst these is mentioned *Akund* Cotton and the reference has led to a moderate degree of enquiry.

In this note *Akund* cotton is said not only to be in good demand for export but large quantities are used in Europe and America for the purpose of making lint cloth and a kind of bandage cloth for rheumatism and gout patients. The paragraph concludes with the remark that there may be other uses for this cotton but these are not known here. In the succeeding paragraph, however, we are furnished with definite information to the effect that this may be used for spinning and for weaving other kinds of cloth, and that people with a knowledge of the cotton trade predict a good future for it.

The same authority proceeds to say that eighty per cent. of *Akund* cotton is supplied from Agra and its surrounding districts. In Bengal it is totally neglected. The *Akund* is one of several kinds of tree cotton found in India and at Agra and the surrounding districts it is in regular cultivation. An incomplete botanical and agricultural account follows. We are assured that the total cost of production may not be more than Rs. 4 to Rs. [illegible] per bigha or for $2\frac{1}{2}$ maunds of clean cotton, which may easily fetch Rs. 30 at the lowest. Sometimes it sells as high as Rs. 20 per maund. The plants do not suffer either from drought or from excessive rain. Besides the profit from the sale of cotton there is a very handsome profit from the sale of the leaves and

the stalks yield a soft and very light fibre which in itself would form a paying industry. Thus far we have followed the Industrial Guide.

Mr. Leake, Economic Botanist to the United Provinces, after examining specimens of *Akond* cotton from the Agra District, kindly informed me that the plant is the common *Madar* (*Calotropis gigantea*) and not a species of Gossypium. The Dictionary of Economic Products gives the name of *Akond* (for Calotropis) as being current in the Hindi, Bengali, Marathi and Gujarati languages. As regards its properties and uses, the *Sap* is said to yield a form of Gutta Percha. (This error, however, has been corrected by Mr. D. Hooper, who says the substance is only a pseudo gutta). A *manna* is said to exude from the plant. The best fibres and floss from the seeds are well-known fibres. The root bark and sap are medicinal. A liquor is reported to be prepared from the juice. The wood is used for gunpowder, charcoal and various parts of the plant are employed for sacred, domestic and agricultural purposes. Full details on all these points can be obtained by a perusal of the valuable article by Sir G. Watt. The truth in a kernel concerning the floss is simply this: the silk cotton from the seeds is known commercially as "Madar Floss," it is employed to some extent for stuffing pillows; Balfour says it is used in Madras for making soft, cotton-like thread and Mr. Moneton found that when a mixture of one-fifth cotton was made, a good weaving cloth, capable of being washed and dyed was produced. Finally, from all accounts, it appears that the floss can only be spun when in combination with cotton, but the variation in its quality and the intermittency of the supply offer practical difficulties in the way of its use. The facility with which *Madar* can be grown even in the most arid and barren situations is sufficient reason for a plea that the plant and its properties should be the subject of earnest investigation, but we cannot believe that it will ever become either a serious competitor to cotton or even a vehicle for its adulteration.— (G. A. GAMMIE).

SUGAR IN BRITISH EAST INDIES.—An interesting series of articles on "Sugar in the British East Indies," by Mr. Peter Abel, has recently come to a conclusion in the *Louisiana Planter*. That Journal rightly says that its readers will find in the several issues that have contained Mr. Abel's articles, a supply of East Indian sugar-cane data nowhere else available.

It is a misfortune, however, to Mr. Abel's readers that his observations were made on a hurried tour through India in the cold weather, and that, as he laments in his article, his opportunities of access to reliable references were so few and far between.

As a result probably of this difficulty of access to official literature we find that the only tables given by him are from one or two official publications of the Bombay Presidency, and in one article cut bodily from a bulletin by Khan Bahadur Sayed Mohomed Hadi, of the United Provinces.

We find, for instance, that he states without reference to differences of practice in different parts of India, that the manurial application is 40 tons of farm-yard manure per acre, followed by 15 to 20 tons of poudrette or 4 tons of safflower cake, which is, to say the least of it, not usual on this side of India.

Owing, again, to the shortness of his stay he does not appear to have been impressed sufficiently by the difference in climatic conditions, and he has thrown the estimated costs and produce of different parts into violent contrast without laying sufficient stress upon the possibility of varying conditions. He appears to be very dissatisfied with the different estimates of cost and profit and throws those of the Punjab into violent contrast with those of Bombay.

Mr. Abel and most of his readers know that Lahore and Bombay are in different latitudes, but mere latitude cannot produce the enormous differences of climate between the two. His lack of access to official literature appears also to have again rather led him astray. In one case, that of Bengal, he states that it is possible that an error was here made from the lack of consideration of cost of labour.

He quotes (*Louisiana Planter*, Vol. XLIII, No. 3) Mr. Banerjee's remark: "It must be remembered that much of the labour expended both in cultivation and the manufacture of *gur* is supplied by the cultivator's own family, and the net profit is, really, therefore, greater than these figures indicate." He appears to read this as meaning that the cost of labour has not been included, for he makes the remark that "this would indicate that Mr. Banerjee has not included the cost at its selling price of the labour employed in growing the cane."

It is difficult to understand in the first place how from Mr. Banerjee's words this inference can be drawn, and in the second the figures published by Mr. Banerjee are the total of a carefully compiled table (Departmental Report on Sugar-cane), showing every item of expenditure from start to finish.

This appears to be the only instance in which Mr. Abel has attempted to account for the discrepancies between figures in different Provinces.

As regards the necessity for irrigation, and his impression that in some cases excessive water is used, it is perhaps certain that the cultivator will take as much water as he can, knowing, as he does, the awful yearly Indian drought which he has to face.

It is a pity, however, that Mr. Abel has not given specific examples of water-logging, instead of merely quoting official figures taken by him from Poona, from which he deduces the fact that water was given totalling 77·5 inches, to which he adds the 16 inches yearly rainfall, ma

He states that this is "

clay soil even if fairly wel

As these figures from

mati in the same Province are the only ones he quotes, we are led to believe that these are the most striking instances of the misuse of water. It is possible that he may have seen water-logging, but, if so, it would add much to the value of his useful article, if he quoted the instances.

Referring to this excessive use of water he states that "this is not likely to occur where the water has to be raised from wells."

Those who have had to irrigate by means of wells will agree with Mr. Abel.

In Patna district the estimated cost of irrigation by canal is Rs. 10-9-6 and by "mote" (from wells), Rs. 18-0-0 per acre, sufficient argument in itself to uphold the cause of the canal against that of hand irrigation. It is possible that the difference may not be so great in other parts of India, but for Bengal at any rate there is no doubt of the saving effected by the great canal systems.

It is obvious that Mr. Abel had no intention of arguing from a special case, and accounts are given by him of agricultural practice all over India; but the limited amount of time and documents at his disposal do not appear to have forced upon him the main difficulties which the Indian Sugar-cane Industry has to face, which are :—First—the system of land tenure; Second—the lack of irrigation: Third—the intense dryness of the majority of India during the months from January to June or July which, unless one has experienced it, renders almost impossible any attempts to give an idea of the amount of irrigation required in figures of inches of water.

The amount of information furnished by this paper is enormous, and the work done by Mr. Abel in collecting it during the few months in which he was in India was colossal. As is to be expected, however, in such a large number of facts it is difficult to avoid an occasional pitfall and almost impossible to lay sufficient stress upon the one or two points that are in all probability of primary importance.

As an account the article is excellent; it is only in Mr. Abel's criticisms in which he perhaps fails, from an insufficient supply of data.

As he himself says (*Louisiana Planter* 43, No. 2, page 29), in connection with the irrigation problem, "many conditions are involved." How many and various these conditions are, can only

be gathered even in one Province by a lengthy residence on the spot, and in a tour of only four months one can hardly do more than touch their fringe. —(C. SOMERS-TAYLOR).

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POTATOES IN UPPER BURMA. —An enquiry as to the origin of the potatoes exhibited for sale in most of the large bazaars of Upper as well as of Lower Burma will reveal the fact that only a small proportion of the potatoes consumed are the produce of this country. Many are imported from Calcutta or from Europe — the so-called "Calcutta" potato is generally the produce of Italy or some other European country; a fair proportion of marketable produce comes down from the Shan States, and the remainder is produced in Burma proper. In no part of the country is the potato extensively grown as a field crop, but it has reached the stage of an important garden crop, the cultivation of which is in some parts gradually extending to field areas. On the islands and inundated lands of the upper reaches of the Irrawady, for example, the potato crop is a regular one in the hands of many cultivators. This is particularly the case in the Bhamo and Katha districts, where the cultivation was probably started by the Shan inhabitants, who still hold a large share of the land under this crop. The Shan, who is usually a better gardener than the Burman, and bestows more care on his crops, evidently recognised the value of these inundated lands for growing potatoes, and was the first to commence their cultivation. But the Burman is an apt pupil when he finds it is to his advantage, and especially in the Bhamo district, he is rapidly following suit—so much so that were it not for the difficulties and heav[illegible] transport the markets of Burma might before long [illegible] the "Bhamo" potato instead of the imported artic[illegible]

Varieties.—In the Bhamo district the following [illegible] varieties are easily recognisable, and some or all of these are cultivated to a small extent along the river at least to the southern borders of the Mandalay district.

The cultivators only distinguish three or four varieties by means of the colour of the skin and the size of the potatoes. In

some cases two or even three varieties were found mixed togethe under one local name. For the purpose of convenience in classi fication these varieties are distinguished by numbers and hav been divided into (1) white-skinned and (2) red-skinne varieties; and each of these divisions may be again divided int (*a*) round and (*b*) oval or kidney-shaped varieties, and so on.

No. 1. A white-skinned variety of medium size and ver regular oval shape, with a rough skin and very shallow eye closely clustered near the "bud" end of the potato. The flesh i white and of excellent quality

No. 2. A white-skinned variety of large size and elongate oval shape; the skin is rough (especially in patches), and th eyes are not deep, but not so shallow as in No. 1, and they ar often distributed throughout the whole length of the tuber. Th flesh is white and the quality very good

No. 3. A white-skinned variety of large size, elongated ov shape and irregular outline with prominences bearing den clusters of eyes. The skin is usually very rough in patches an the eyes are shallow but densely clustered on the end and on th lateral prominences of the potato. Flesh white or slightl yellowish in colour and of good quality, though somewhat coar and not equal to Nos. 1 and 2.

No. 4. A white-skinned variety of large size and round shap outline not very regular. The skin is smooth and the eyes ve deep. The flesh is yellow and not of very good quality, bei hard and waxy when boiled.

No. 5. Very small potatoes called by the cultivato "Shan" potatoes, mostly round in shape and rough skinne The flesh may be white or yellow. These potatoes appe to be a mixture of the "chats" or small potatoes of th preceding white varieties, and are sold at a little over half th price of the larger ones.

No. 6. A red-skinned variety of fairly large size and som what irregular oval shape. The skin is smooth and the eyes a not deep. The flesh is white streaked with pink and of very go quality when boiled.

PLATE II.

PLATE III.

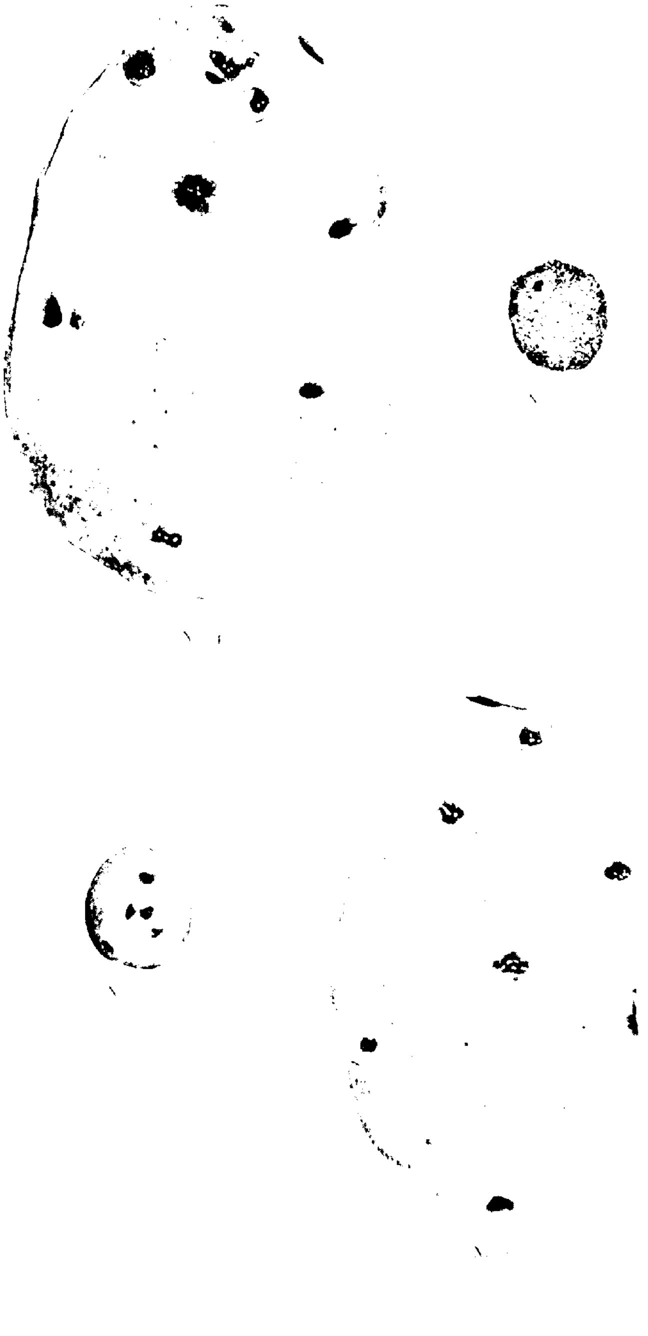
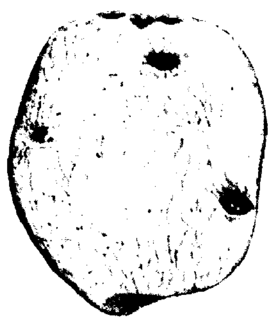


PLATE IV.



A. J. I.

No. 8.

No. 7. A variety with a red skin, of medium size and oval shape, skin smooth and eyes of moderate depth, the flesh is white, sometimes slightly yellowish, and the quality is good.

No. 8. A round red-skinned variety with very deep eyes. The tubers are of fair size only, and the flesh white to slightly yellowish in colour. When boiled the quality is good.

Cultivation is generally very simple and takes place only in the cold weather—except in some parts of the hills where it is cold enough for the successful cultivation of potatoes during the rains. The chief methods are shortly as described below :—

I. *On Inundated Lands.*—Though the islands and low-lying lands along the banks of the Irrawady River, which are annually inundated during the rainy season, are, generally speaking, well suited for the cultivation of potatoes and other vegetables, there still remain large uncultivated tracts. The soil is either sandy or of a very light loamy nature and very easy to cultivate. In many places where the water does not flow rapidly over the land, but simply rises and falls gradually, deposits of fine silt or mud are often left behind; and apart from these deposits manure is seldom used, except near the villages where a little cowdung or sweepings may be applied before ploughing. As soon as the water leaves the land, usually about the beginning of October, cultivation is commenced. The land is ploughed once with the "hte" and harrowed with the "htun" two or three times until it is cleared of weeds and a fine tilth secured. Sometimes it is only harrowed. The sets are usually planted whole and in rows by being placed in holes made to a depth of 4 or 5 inches at a distance apart of one cubit (*i.e.*, about 15 to 18 inches). The distance apart of the rows is also about 15 inches and the holes are made by hand by the aid of the "paukpya" or "mamootie," the "tuywin" (spade), a stick or any convenient implement. No drills are raised, and after dropping the sets the holes are filled in with earth. Very little choice of sets is made, except that, as a rule, the very small ones are discarded, and cut sets are said to decay rapidly instead of sprouting. As soon as the shoots appear above ground, hoeing is done between the rows

and is repeated two or three times during growth. At each hoeing the loose soil from between the rows is heaped up slightly around the plants. Irrigation is not generally carried out and the crop is ripe in about four months after planting. When the haulms have assumed a yellow colour and before they are completely dead, the potatoes are dug up by hand.

II. *On the higher lands* they are, as a rule, grown in gardens only and often receive a little manure in form of cattle dung, village scrapings, etc. They are planted out at the end of the rainy season and cultivated in a way similar to that described above.

III. *On the hills* they are also cultivated as a garden crop and receive a good supply of cattle manure. Though usually a cold weather crop, in the higher Kachin Hills they were seen growing in the warm weather, having been planted about the beginning of March. They were not planted in rows but irregularly at distances of about 18 inches apart. The transport difficulties from these hills prohibit the growth of potatoes for export to Burman markets.

Rotations.—With garden crops definite rotations are rarely followed, but potatoes are often seen growing mixed with oil-seeds and vegetables—particularly cucumbers of various kinds. On the river lands they may be rotated with a grain crop or with sessamum, but generally they are grown together with vegetables, and as unoccupied land is usually abundant, the cultivator takes only a few crops in succession before leaving his land fallow. During flood time also the lands here are constantly being washed away and new lands formed.

Outturn.—The figures obtained are somewhat confusing and probably not very reliable, but the outturn is nowhere very large not more than four or five tons per acre in the best places. The yield is often very considerably reduced by the attacks of Potato disease (Phytophthora), which appears to be very common.

Prices.—At Bhamo the prices run from anna one to a little over annas two per viss (3·65 lbs.). The higher price was paid for the best of the large varieties and the lower for the small "Shan"

varieties. In Mandalay the average prices per viss may be taken as follows :—

Best Calcutta potatoes	...	...	...	4 to 4½ annas.
Large Burmese or Shan	...	..	...	4 annas.
Medium do. do.	...	...	...	3 annas.
Small "Shan" potatoes	...	..	...	2 to 2½ annas

At these prices it is quite probable that the increase in area under potato cultivation in Upper Burma will continue, and as the quality of some of the large varieties is quite equal to the best imported potatoes, there is no reason why the supply for our chief markets should not be grown in this country.—(E. THOMPSTONE).

REVIEWS.

Principles and Practical methods of curing tobacco by W. W. Garner, Bull. 143, Bureau of Plant Industry, U. S. Department of Agriculture, February, 1909

During recent years the study of the many aspects of the production and curing of tobacco in the United States has engaged the increasing attention of the Bureau of Plant Industry at Washington. At the present time no less than sixteen members of the scientific staff of this section are working on the improvement of tobacco. The results so far obtained are said to have attracted considerable attention on the part of practical men and a good deal of the work appears to be carried on in co-operation with the growers. The present bulletin deals with two main subjects. In the first place, attention is devoted to a popular exposition of the scientific principles underlying the various curing processes, while the second part of the paper consists of an illustrated account of the practical methods of curing as applied to the various types of tobacco grown in the United States, such as cigar, barley, yellow and heavy export tobaccos. This bulletin is perhaps the best summary of a many sided subject which so far has been written and will no doubt be read with interest by all engaged in the improvement of the tobacco crop in India.—(A. Howard).

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Second and Third Annual Reports of the Committee of Control of the South African Central Locust Bureau 1908-1909.

In a previous issue (Vol. IV, Part 3) we noticed the work of the Locust Bureau as detailed in its first annual report. We

have now the Reports for the whole period 1907 to 1909, prepared by C. Fuller and C. P. Lounsbury. The Bureau has settled down to practically two functions: the first is the collection of all data regarding the occurrence and movements of Locusts in the Cape Colony, Natal, Transvaal, Orange River Colony, Southern Rhodesia, Bechuanaland Protectorate, Basutoland, Swaziland, Mozambique and German South West Africa, with the issue of warnings to all these areas; the second is the gathering together of reports of the action taken in each area by the several Governments concerned, and the communication of these to the others. It is a co-ordinating bureau, with no powers of control, jointly maintained by all the Colonies which benefit.

Two kinds of locusts are concerned, one essentially a desert species which breeds in arid sandy areas and thence flies out in swarms, the other dependent upon moister conditions. The first is normally an inland species, starting from the Kalihari Desert, the other a Coastal species, originating in the moister areas near the sea; the period of life in both is normally one year, but the eggs of the first, if not slightly moistened, retain vitality for years and hatch out when rain falls. This complicates the problem and as both species, when abundant, fly over long distances, the necessity of a joint "Intelligence Bureau" is fully shown.

In 1907-1908 a sum of about Rs. 6,00,000 was spent in the whole area, and this is estimated to be about one per cent. of the damage that the destroyed locusts would have caused had the work not been done. A feature of the year was the extraordinary destruction of the eggs by parasites ("which destroyed quite two-thirds of those laid") in Natal and the amount of good done by locust eating birds generally. In this connection it is worth note that, at a full meeting of the Committee, it was unanimously resolved that it was impracticable to increase the efficiency of the insect, fungus and other natural enemies of locusts in South Africa, beyond affording protection to the birds and small animals that destroy them, and also that *it would*

do no good to import parasites or other enemies from over-sea countries. This is the definite opinion of a gathering of practical and experienced agricultural entomologists.

Generally speaking, one standard method has been adopted, the application of a strong arsenical solution, sweetened, to the vegetation that the hoppers will eat. In some cases the materials are provided by Government, in others legislation enforces the use of the method. Longer experience of this method is emphasizing the danger of Stock-poisoning, cattle getting access to the poisoned vegetation, but this is a very small item of loss which is expected to disappear with practice.

The 1908-1909 report shows that the poisoning method remained in force and that the value of another method, where it was practical, had become established; this was to drive the hoppers into dry grass and burn it. The report states "of such high importance is the last-mentioned measure, that whenever feasible, patches of old grass should be preserved for the purpose when an appearance of voetgangers (hoppers) is anticipated." An improvement made in the poisoning was to issue a concentrated sweet arsenical solution, rather than to issue the white arsenic, soda, and sugar to prepare it on the spot.

Three years of experience of this method since the Locust Bureau was started has not materially modified it and the Bureau are to be congratulated on having a reliable method for exterminating locusts and upon the extremely useful nature of the work they are doing.—(H. M. LEFROY).

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LEGUME BACTERIA.—A very interesting pamphlet on this subject by Drs. Edwards and Barlow is published as Bulletin No. 169 of the Ontario Department of Agriculture. Work on the isolation, cultivation, and preservation of nodule bacteria from various leguminous plants has been in progress in the bacteriological department of the Ontario Agricultural College for more than five years and in previous publications (Centrallblatt für Bakteriologie, II Abt., Vol. 19, 1907), the results obtained

up to 1906 have already been summarised. An account was given of the isolation of B. radicicola from 14 different species of legume belonging to four different genera and the media which had been found most suitable for their cultivation were described.

In the present publication the isolation of the organism from 12 further species, and experiments with modified media are recorded. It is found that for general purposes media of the following composition give the most satisfactory results :—

Water	100 parts.
* Ash	·4 to 1 part.
Maltose	·4 to 1 „
Agar	·4 to 1·5 „

It is found that dextrose, mannite, and amygdalin can advantageously replace maltose in solid media, but the substitution of asparagin or inulin leads to very scanty growth, and that of levulose to complete inhibition. In liquid media maltose appears to be the best of a number of sugars tried, and levulose prevents growth altogether just as it does in solid media.

Since 1905, the Ontario Department of Agriculture has been distributing cultures of various nodule bacteria on an ash-sugar-agar medium to farmers for the inoculation of crops. In this connection an account of a series of experiments, which is in progress, on the vitality of the bacteria in cultivation on this medium and on seeds after inoculation with the culture is most welcome. Investigations on these points, which are fundamental to any possibility of the distribution of cultures for inoculation being a practical success, have been conspicuous by their absence in the many publications on the subject which have recently been issued. The Ontario observers show that cultures on their medium have remained alive for well over a year in nearly every case and, in some instances, for two, or even three, years, and that a considerable number of the bacteria remain alive on the seed, after inoculation and drying, for periods up to 13 days. Furthermore they have satisfied themselves that the inoculated

* The ashes from maple or mixed beech and maple, from elm, and from tamarisk were used with equally favourable results.

seed sown by the farmers to whom the inoculating material was sent did actually bear living bacteria by collecting samples of it from a large number of them and finding living bacteria in considerable numbers still present.

So far this is all very satisfactory; but what one feels is lacking in the Ontario experiments, as in most others which have been carried out on the same plan in other parts of the world, is sufficiently satisfactory evidence that any benefit has actually been derived from inoculation. During the four years 1905-1908, 3,106 cultures were issued to farmers; of these only 1,012 (or about 32·6%) sent in reports to the Agricultural Department and only 627 (or about 20%) recorded successes. Now, disregarding the probability that a farmer would more readily send in a report if he had to record a success than a failure, let us assume that the same proportion of those who did not report, obtained successful results as of those who did so. On this assumption we conclude that, out of 3,106 cultures issued 1,309 (or about 42%) led to positive results; a very small proportion if we are to believe that inoculation is likely to be of anything like universal benefit and, that the experiments were accurately carried out and recorded. But in this latter reservation lies the whole difficulty of the case. The appeal to the practical man is the order of the day in agricultural experiments, and, naturally, the ultimate verdict as to the value of any new practice introduced into agriculture by science must rest with such appeal; but it is, to say the least of it, extremely doubtful whether the appeal should be made until very searching practical tests have been carried out by fully qualified investigators. The difficulties of carrying out comparative experiments in agriculture accurately are so great that, in a matter of the sort we are dealing with, the results recorded by farmers are not likely to be worth much, and we should have welcomed some figures bearing on the practical application of the cultures derived from experiments carried out by Drs. Edwards and Barlow themselves. It may be that some special advantage attaches to their method of preparing and preserving their cultures. Cultures prepared and preserved in

different ways have not, so far, given anything like uniformly satisfactory results in the hands of competent investigators in other countries, and we should have liked to see some really reliable evidence of the relative value of the Ontario preparations from the practical standpoint.—(C. BERGTHEIL).

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